Chronica Botanica, Volume 9, Number 1

HOMER A. JACK

Ph.D. (Cornell), B. D. (Meadville); Executive Secretary, Chicago Council Against Racial and Religious Discrimination; Sometime Lecturer, Athens College, Athens, Greece; Sometime Minister, Unitarian Church, Lawrence, Kansas.

BIOLOGICAL FIELD STATIONS

of the

WORLD

Single copies of this number $2.50

Issued Summer 1945

the Chronica Botanica Co., Waltham, Mass., U.S.A.

New York City, G. E. STECHERT AND CO.; San Francisco, J. W. STACEY, INC.; Ottawa, THORBURN AND ABBOTT, LTD.; Mexico, D. F., AXEL MORIEL SUCRS.; Bogotá and Medellín, LIBRERIA CENTRAL; Lima, LIBRERIA INTERNACIONAL DEL PERU; Santiago de Chile, LIBRERIA ZAMORANO Y CAPERAN; Rio de Janeiro, LIVRARIA KOSMOS; São Paulo, LIVRARIA CIVILIZAÇÃO BRASILEIRA; Buenos Aires, ACME AGENCY; London, WM. DAWSON & SONS, LTD.; London, H. K. LEWIS AND CO., LTD.; Groningen, N. V. ERVEN P. NOORDHOFF; Paris, LIBRAIRIE H. LE SOUDIER; Torino, ROSENBERG & SELLIER; Lisbon, LIVRARIA SÁ DA COSTA; Moscow, MEZHDUNARODNAJA KNIGA; Calcutta, Bombay and Madras, MACMILLAN AND CO., LTD.; Johannesburg, CENTRAL NEWS AGENCY, LTD.; Melbourne, N. H. SEWARD, PTY., LTD.

This book is presented

by

The Government of the United States

as an expression of

Friendship and Goodwill

of the

People of the United States

towards

The People of India

Chronica Botanica

Agronomia — Biologia — Genetica

Chronica Botanica

An International Collection of Studies in THE METHOD *and* HISTORY *of* BIOLOGY *and* AGRICULTURE

edited by FRANS VERDOORN, PH. D.

Managing Editor of 'A New Series of Plant Science Books' and 'Annales Cryptogamici et Phytopathologici'; Assoc. Editor, 'Natuurwet. Tijdschr. voor Ned.-Indië', 'Rec. Trav. Bot. Néerl.', 'Farlowia', 'Bryologist'; Bibliographer, Arnold Arboretum of Harvard University; Botan. Adviser, Board for the Netherlands Indies; Hon. Sec., Bot. Section of the Int. Union of Biological Sciences; Hon. Sec., Committee for Hepaticae of the Int. Nomenclature Commission; etc.

A link between plant scientists in all branches and in all countries

Volume 9 1945

WALTHAM, MASS., U.S.A.

Published by the Chronica Botanica Company

Phytopathologia — Silvicultura — Horticultura

MEMORIAE VIRI ILLUSTRISSIMI

MELCHIORIS TREUBII

GLORIOSI NOMINIS DIGNI HEREDIS

HIC CHRONICORUM BOTANICORUM

TOMUS NONUS

PIO GRATOQUE ANIMO

DEDICATUR

PRIMUS VIR BOGORI NECNON TJIBODAE

INVESTIGATORIBUS EXTRANEIS LOCUM

AD

BIOLOGIAM TROPICAM INQUIRENDAM FECIT

OPUSQUE TREUBIANUM IN POSTERUM PERMANEBIT

EXEMPLUM

INVESTIGATORIBUS DIRECTORIBUSQUE DIGNISSIMUM

We never can forget
Those rubber boots, those bathing suits,
And that collecting net.
Those sings and things will soon take wings
But thru the coming years
Whate'er the scene, dear formaline
Will fill our eyes with tears,
Whate'er the scene, dear formaline
Will fill our eyes with tears.
WOODS HOLE MARINE BIOL. LAB. SONG

Oh the wonderous laws which bind
Living things of every kind,
And control their distribution in the lake,
Temperature and CO_2
Pressure, light, and ions too,
All determined by the tests we've learned to make.
UNIV. OF MICHIGAN BIOL. STA. SONG

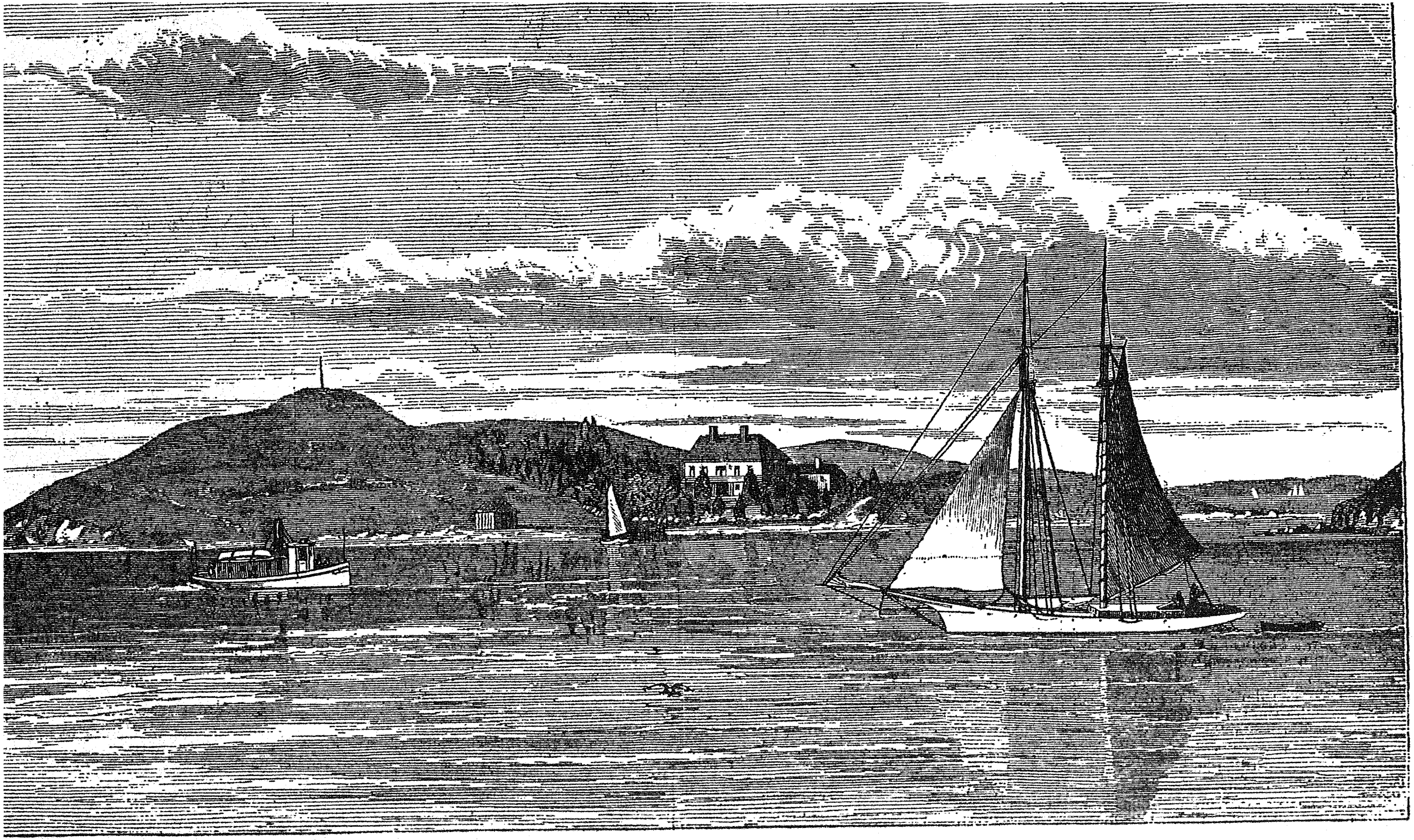
Oh we are the students of M.B.L., and a jolly gang are we
We dig, we cut, we fish around from morn till dewy eve,
We mutilate the flat worms, and tickle the lobster's toes
And wonder why old Nereis has warts upon his nose.
Wig, wig, wig, wig, wiggle old Nereis goes
Tick, tick, tick, tick, tickle the Lobster's toes,
Exopodite, endopodite, basipodite as well
What happens to these animals I'd surely hate to tell.
CHARLTON, SPEIDEL & KINDRED (1919)

I want to go back to Douglas Lake
The dear old camping ground,
Back to the mess hall on the hill,
Back to the fun in ladyville,
Back to the labs with all their joys
In which we did partake,
I want to go back, I've got to go back
To Douglas Lake.
UNIV. OF MICHIGAN BIOL. STA. SONG

There are bugs that make us happy,
There are bugs that make us sore,
There are bugs that spoil our dispositions
Till we never want to see them more,
There are bugs so very complicated
That their heads from tails we cannot tell
But the bugs that fill our hearts with sunshine,
Are the Big Bugs from M.B.L.
WOODS HOLE MARINE BIOL. LAB. SONG

• Chronica Botanica, Volume 9, Number 1 •

BIOLOGICAL FIELD STATIONS *of the* WORLD



Agassiz's School on Penikese Island (*Contemporary woodcut from Harper's Weekly*).—For reports of this early American laboratory, founded in 1873 by Agassiz, *cf.* bibliography, p. 11. For a recent interesting account see L. C. Cornish 1943, Sci. Mo. 62:315-321.

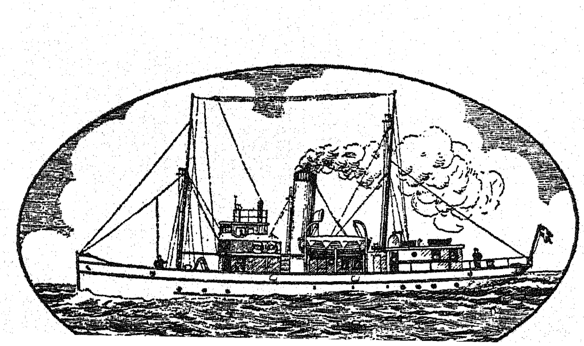
BIOLOGICAL FIELD STATIONS of the WORLD

by

HOMER A. JACK

Ph. D. (Cornell), B. D. (Meadville); Executive Secretary, Chicago Council Against Racial and Religious Discrimination; Sometime Lecturer, Athens College, Athens, Greece; Sometime Minister, Unitarian Church, Lawrence, Kansas.

"I have made use of the term 'biological station' in preference to those in more common use for the reason that my ideal rejects every artificial limitation that might check growth or force a one-sided development. I have in mind, then, not a station devoted exclusively to zoology, or exclusively to botany, or exclusively to physiology; not a station limited to the study of marine plants and animals; not a lacustral station dealing only with land and freshwater faunas and floras; not a station limited to experimental work, but a genuine biological station, embracing all these important divisions, absolutely free of every artificial restriction." (C. O. WHITMAN, Science 7:37, 1898)



PRINTED IN THE UNITED STATES OF AMERICA

CONTENTS

The purpose of this study is to synthesize and present heretofore scattered and unpublished materials describing and comparing the biological field stations of the world. If this purpose is partially fulfilled, prospective students and investigators will have a guide to aid them better in selecting a station in which to study or conduct research work. In addition, it is hoped that this study will be of some benefit to the directors of biological stations, since it may show them how their fellow-administrators are solving some of the problems attendant to the efficient organization of these institutions in many parts of the world. Finally, if a theoretical justification for studying these institutions need be given, it is merely that they have loomed large in the progress of biological instruction and research in the past and—providing they retain their adaptability—there is every reason to believe that they will remain equally important in the future.

Although biological stations have been in existence for more than eighty years, there is a paucity of literature about them. Biologists have been prone to leave the study of their institutions to others who rarely have the insight, if the interest, to make extensive analyses (20). The few materials which have been published about biological stations fall into several categories:* 1, *articles on the functions of these institutions, especially by* ANTON DOHRN *(1), Professor* C. O. WHITMAN *(2), and most recently by Professor* PEARSE *(3)* ; 2, *articles describing a particular station;* 3, *articles on several stations of a region or functional group; and* 4, *articles in the form of a directory of the stations in larger political units.*

The first directory for any large political or geographical area was published in 1893 by BASHFORD DEAN *(4). This consisted of a discussion of the marine laboratories of Europe. It was followed in 1898 by* RENÉ SAND'S *account (5) of the biological stations of the world. In 1899* HENRY WARD *(6) published a paper on the fresh-water biological stations of the world and in 1910* CHANCEY JUDAY *(7) wrote an account of European biological stations.*

The first extensive study of biological stations was made in 1910 by Professor KOFOID *in his bulletin on the "Biological Stations of Europe" (8). In 1927* LENZ *(9) published his valuable directory of limnological laboratories and in the same year* MAGRINI *(10) issued his list of institutions occupied with the study of the sea. In 1928 the General Biological Supply House of Chicago began to publish its annual booklet on "Biological Field Work" (11) at North American stations. Professor* T. W. VAUGHAN *in 1937 issued his important "Catalogue of Institutions Engaged in Oceanographic Research" (12) and in that same year the author's unpublished study (13) on the biological field stations of the United States was completed.* CHRONICA BOTANICA *(14) in 1938 published a world list of scientific institutions which contained a more complete enumeration of biological stations than had ever appeared in the editions of "Minerva," "Index Generalis" or "Index Biologorum." In 1940, the author published a short description of the United States stations in "The American Biology Teacher" (15) and a series of articles on the European stations in "The Collecting Net" (16). Also in 1940 the author completed his unpublished manuscript on "The Biological Field Stations of the World" (17), of which this study is a part.*

In addition to reviewing the existing literature, the author tried to study these institutions first-hand. Besides being a student and investigator at two stations for five summers, the author attempted to visit as many of these institutions as his time and resources permitted. Seventy-nine stations in eighteen countries in Europe, North Africa, and North America were visited by the author between 1937 and 1941. These visits and interviews (18) were supplemented by questionnaires in English and French to the directors of the stations not visited.

It must be emphasized that, with few exceptions, the descriptive and analytic accounts of the biological stations given in this study are corrected to 1940—before the second World War became world-wide. As the war progressed, many of these institutions greatly curtailed their activity and even suspended operation for the duration

* Notes and references will be found at the end of this introduction and at the end of each part of the first section of this account.

of the war. Indeed, a few stations were casualties of the war (19). Despite these changes wrought by the war, it has been thought useful for biologists and other scientists to have a picture of the biological stations of the world at perhaps the peak of their operation (1939-40). Thus even before the war is over or sectional armistices are declared, information on these institutions will be in the hands of those who, as students, investigators, and administrators, will be responsible for helping to make them again serve science and mankind.

Many biological stations normally print descriptive catalogues giving seasonal or up-to-date information on the research and instructional facilities available. Prospective students and investigators are urged to send for such a catalogue and correspond with the director before making definite arrangements to attend any station. If desired, the author through one of the CHRONICA BOTANICA *publications will continue to act as a clearing house for information about these institutions. And if there is a demand, perhaps a second, post-war edition of at least the descriptive portion of this study can be issued.*

The author is under deep obligation to all those who have helped to make this study possible, especially to Professors EDWIN CONKLIN, E. A. ANDREWS, *and* JACOB REIGHARD *who, as patriarchs of biological field work in America, have given him valuable historical materials; to Professors* E. LAURENCE PALMER, ALBERT HAZEN WRIGHT, *and* LEONARD S. COTTRELL, JR., *of his graduate committee at Cornell University; to Professors* ROBERT E. COKER *and* GEORGE R. LARUE *who, as former directors of the Allegany School of Natural History and the Biological Station of the University of Michigan respectively, accepted the author as a student in their institutions before he matriculated in college; and to Dr. and Mrs.* FRANS VERDOORN, *without whose aid and encouragement this study could not have been published.*

The author is grateful to the directors of all of the biological stations for helping him to compile the descriptive part of this study and often for giving him hospitality during his brief visits to many of these institutions. The author is especially grateful to Dr. W. BEIJERINCK *of the Biologisch Station at Wijster, Professor* J. BRAUN-BLANQUET *of the Station Internationale de Géobotanique Méditerranéenne et Alpine, Professor* ATTILIO CERRUTI *of the Istituto Demaniale di Biologia Marina di Taranto, Dr.* C. CROSSLAND *formerly of the Marine Biological Station of the Fouad I University, Professor* ODÓN DE BUEN *formerly of the Instituto Español de Oceanografía, Dr.* ROBERT B. GORDON *of the Allegany School of Natural History, and Dr.* F. RUTTNER *of the Biologische Station Lunz.*

Above all, the author is deeply indebted to his parents, CECELIA *and* ALEXANDER JACK, *who sought in every possible way to give him opportunity for study and travel. To them, this study is dedicated.*

CHICAGO, ILLINOIS, U. S. A.
5701, S. WOODLAWN AVE.

References and Notes: — (1) The foundation of zoological stations. Nature 5:277-80, 437-40, 1872. Also, Report of the committee . . . for the foundation of zoological stations in different parts of the globe. Report of the British Association for the Advancement of Science 1873:408-12, 1874. — (2) Some of the functions and features of a biological station. Science 7:37-44, 1898. — (3) A. S. PEARSE: Marine biological stations. Tennessee Academy of Science 17 (4) :345-47, 1942. — (4) Notes on marine laboratories of Europe. American Naturalist 27:625-37, 697-707, 1893. Also this article may be found in the Report of the Smithsonian Institution for 1893, pp. 505-19, 1894. —(5) Les laboratoires maritimes de zoologie. Revue de l'Université de Bruxelles 3:23-47, 121-51, 203-35, 1898. —(6) The freshwater biological stations of the world. Science 9:497-508, 1899. Also this article may be found in the Report of the Smithsonian Institution for 1898, pp. 499-513, 1899. — (7) Some European biological stations. Transactions of the Wisconsin Academy of Sciences, Arts, and Letters 16:1257-77, 1910. — (8) CHARLES ATWOOD KOFOID: The biological stations of Europe. United States Bureau of Education Bulletin 1910 (4) :1-360, 55 pls., 48 figs., 1910. — (9) F. LENZ: Limnologische Laboratorien. Handbuch der Biologischen Arbeitsmothoden 9:2(1) :1285-1368, 1927. — (10) G. MAGRINI: Instituts et laboratoires s'occupant de l'étude de la mer. Conseil International de Recherches, Union Géodésique et Géophysique Internationale, Section d'Océanographie, Bulletin 7:1-115, 1927. — (11). This appeared in 1928, 1929, 1930, 1931, 1932, 1934, 1935, 1937. Mimeographed lists of the biological stations of the United States and Canada were issued by this supply house in 1938 and 1939. In 1940 the list appeared in Turtox News 18(3) :49-51. — (12) *In* International aspects of oceanography (T. W. VAUGHAN and others). Washington:

National Academy of Sciences. 1937, pp. 73-225. — (13) HOMER A. JACK: Biological field stations—their history, organizations, educational contributions, and conservation relations. 196 pp., 26 figs., 37 tables. (Unpublished thesis, Cornell University Library). 1937. — (14) FRANS VERDOORN (*ed.*): World list of institutions, stations, museums, gardens, societies, and commissions. Chronica Botanica (Leiden) 4(4-5):301-83, 1938. — (15) HOMER A. JACK: Close to nature: biological field stations. The American Biology Teacher 2:141-45, 180-83. 3 figs., 1940. — (16) HOMER A. JACK: The biological field stations of Europe. The Collecting Net (Woods Hole) 15:5-6; 25, 31-33; 45, 51-52; 70-71; 96-98; 117-18; 137-38; 152-53; 184-86; 206-08, 1940. — (17) HOMER A. JACK: The biological field stations of the world—A comparative and descriptive study. 1,001 pp., 114 tables, 4 plates. (Unpublished thesis, Cornell University Library). 1940. This may be obtained from the Cornell University Library through inter-library loan. — (18) *Cf.* HOMER A. JACK: Language difficulty. Science 89:558. 1939.—(19) "During the recent air raids of Plymouth, the Laboratory of the Marine Biological Association suffered severely. The buildings, though still standing, have sustained heavy damage. All windows except a few on the south side of the top floor of the main building have gone; ceilings are down, doors wrenched off, and much structural damage caused by the blast. The director's house was completely burned out. The library, very fortunately, is intact except for the loss of windows and the skylight, and it has now been made waterproof . . . The Easter class house will no doubt have to be rebuilt, but most of the roof remains. Other buildings, including the dogfish house, director's garage and stores, and the constant temperature rooms, have all sustained damage . . . The tanks on the north side of the Aquarium burst and the supply pipes broke, but it is hoped that some part of the circulation may be restored before very long . . ." (*cf.* Science 93:445). — (20) An outstanding exception is The Woods Hole Marine Biological Laboratory, *by* FRANK R. LILLIE. University of Chicago Press, 284 pp., 1944.

The Purpose of Biological Stations: — A biological field station may be considered as any institution which offers field instruction or research in one or more of the theoretical biological sciences and is a separate administrative unit located in the field. In the actual practice of the institutions, the pendulum has swung between research and instruction several times. And the problem has always been, as Professor C. O. WHITMAN posed it in 1893, "to combine the two [instruction and investigation] in such relations that each would contribute most to the same end — the advancement of science"[1].

Nineteenth Century Stations. — In the nineteenth century, three principal types of biological stations evolved. The first kind of station to develop in Europe was the seaside laboratory and aquarium. Facilities were furnished for marine research, with a public aquarium being maintained principally to subsidize the research work of the institution. The Zoological Station of Naples fell into this class. Its founder, Dr. ANTON DOHRN, rightfully called it "a battlefield where all the different zoological armies [systematists, anatomists, physiologists, and embryologists] may meet and fight their common adversaries [error and ignorance]"[2].

Quite opposite in purpose was the seaside school of natural history which was the first kind of station to appear in America. Its aim was to offer marine instruction to students and teachers. With the establishment of this type of station, of which LOUIS AGASSIZ's Anderson School of Natural History was representative, the battle royal began. Professor E. RAY LANKASTER, for example, wrote contemptuously in 1880 of AGASSIZ's venture, "the spasmodic descent upon the seacoast in a summer vacation . . . is a delightful thing . . . but it is not in this way that the zoology of today can be forwarded"[3].

Toward the end of the nineteenth century, a practical compromise was reached in this controversy with the rise of the third kind of station, the

so-called marine observatory. Here both marine research and instruction were combined to varying degrees. The Marine Biological Laboratory at Woods Hole, Massachusetts, was a representative of this type of station. Professor WHITMAN, its director, realistically described its practice when he said, "instruction . . . was accepted more as a necessity than as a feature desirable in itself. The older ideal of research alone was still held to be the highest, and by many investigators was regarded as the only legitimate function of a marine laboratory"[4].

Twentieth Century Stations. — It had been occasionally implied that biological stations made their maximum contribution to the progress of biology during the nineteenth century and that in the twentieth century they would decline. Not only have these institutions survived, but they have flourished, principally due to their adaptability from nineteenth century patterns to twentieth century needs. The typical biological station of the twentieth century has been organized to encourage research and instruction in one or more of the biological sciences by offering facilities for these types of work in one or more kinds of environments. This emphasis on various environmental conditions, in addition to the seaside, was envisaged by Professor WHITMAN, "I have in mind . . . not a station limited to the study of marine plants and animals; not a lacustral station dealing only with land and fresh-water faunas and floras . . . but a genuine biological station, embracing all these important divisions"[5]. In addition to exploring new types of biological environments, typical biological field stations have often sponsored actual research projects. Also there has been a new appreciation of the importance of instruction. As Professor WHITMAN prophetically stated, "with increase and specialization in science the investigator himself becomes more and more dependent upon the instruction which he draws not only from books and journals, but also directly from his colleagues and his pupils. . . We could not wisely exclude instruction [from biological stations] even if made free to do so by an ample endowment"[6].

Despite the rise in the twentieth century of the typical biological station which offers both research and instruction, a number of contemporary institutions have confined themselves either to research or instruction. The biological research station confines itself solely to providing opportunities for research in addition to carrying on research projects of its own. Thus Dr. REINHARD DOHRN re-emphasized the original purpose of the twentieth century Zoological Station of Naples, "It was founded to enable naturalists to carry on their studies with the utmost economy of time, energy, and money. This is still, in my opinion, its fundamental *raison d'être*"[7]. Opposed to the biological research station is the biological nature camp, an institution largely American in origin. Its purpose is to train students in elementary field biology (*i.e.*, nature study).

Quantitatively, it is estimated that about one-half of the contemporary biological stations in the world are biological research stations, offering no facilities for instruction. About two-fifths of the world's stations offer both facilities for instruction and research, while about one-tenth of these institutions offer instructional facilities only. For the stations in the United States, the proportion differs: slightly less than one-half are typical biologi-

cal field stations offering both instruction and research; one-fourth are biological research stations; and almost one-third are biological nature camps.

Perhaps a case could be made for the relationship between the longtime political and educational philosophies of a country and the purposes of the biological stations within its borders. It is worth noting that some of the democracies with a tradition for popular education emphasize formal instruction at the biological stations within their borders (*e.g.*, three-quarters of the United States stations and more than two-thirds of the British stations), while some political areas without a long democratic tradition emphasize research (*e.g.*, more than one-half of the German stations, more than four-fifths of the Russian stations, and all of the Italian stations).

References:—(1) Pop. Sci. Mon. 42:459-71, 1893. — (2) Rept. Brit. Assoc. Advan. Sci. 1873:408-12, 1874. — (3) Nature 21:497-99, 1880. — (4) Science 7:37-44, 1898. — (5) *Ibid.* — (6) *Ibid.* This was reaffirmed forty years later by the trustees of the Marine Biological Laboratory. *Cf.* FRANK R. LILLIE: The Woods Hole Marine Biological Laboratory. University of Chicago Press, p. 92, 1944. — (7) Nature 113:449-50, 1924.

The History of Biological Stations: — From the incomplete historical material available, it appears that the first biological station — as the term has been previously defined—was established in 1859 at Concarneau, France. Earlier in the nineteenth century, biologists came to recognize the value of staying in one place long enough to be able to study living materials in their natural environment. As Professor R. LEGENDRE said, "Bientôt, la simple récolte et la seule dissection ne suffirent plus"[1]. In the eighteen thirties some Swedish naturalists established what Professor CHARLES A. KOFOID called "an impromptu summer biological station"[2]. In 1843 at Ostend, Belgium, Professor P.-J. VAN BENEDEN founded what RENÉ SAND[3] considered the first biological station in the world. LEGENDRE likewise said that this was "le premier centre d'études maritimes,"[4] although KOFOID[5] considered it as merely a kind of formalized seaside excursion and not the first biological station in the world. In that same decade Professor CARL VOGT made several unsuccessful attempts to establish a biological station and in 1848 Professor VALENCIENNES, an associate for a time to Baron CUVIER, began to explore the coast of Brittany for biological specimens. His efforts resulted in the establishment, in 1859, by Professor J. J. COSTE of what exists today as the Laboratory of Marine Zoology and Physiology of the College of France at Concarneau. Fourteen years later, the first station was founded in North America: LOUIS AGASSIZ's Anderson School of Natural History on Penikese Island[6]. About the same time Dr. ANTON DOHRN founded the Zoological Station of Naples.

Their Increase. — The biological station idea spread swiftly and in many directions from its original centers in northwestern France (Concarneau) and in northeastern United States (Penikese Island). In the decade ending in 1880, sixteen biological stations were established, scattered between Sweden and the Black Sea in Europe and Illinois and Virginia in the New World. And by 1888 both the Marine Biological Laboratory at Woods Hole, Massachusetts, and the Laboratory of the Marine Biological Association at Plymouth, England, were in operation. The greatest number of

field stations were founded in the decade ending in 1930, when seventy new ones were established. Although these institutions have almost continuously been abandoned, there has been a net increase in the number of new stations established each decade, with a notable lessening of this increase in the decade including the first World War and the decade after the depression of 1929.

Their Founders. — Biological field stations have been established by many different types of individuals and institutions. Although most biological stations exist, at least in part, to aid scientific research work, scientists themselves have not always had the financial resources to establish these institutions. There have been a few scientists (*e.g.*, ANTON DOHRN or ALBERT I, Prince of Monaco) who have been able to use their private fortunes to build up biological stations. Less wealthy scientists have had to use their personalities to persuade others to give. Both royalty (*e.g.*, King FERDINAND I of Bulgaria) and business men (*e.g.*, JOHN ANDERSON) have been patrons for the establishment of these institutions.

Most biological stations, however, have been established by the help of an institution or special committee, with some one scientist taking the administrative initiative. A list of the types of institutions which have aided in the establishment of biological stations include governmental departments (*e.g.*, Danish Ministry of Agriculture), national scientific institutions (*e.g.*, Carnegie Institution of Washington), national scientific societies (*e.g.*, Netherlands Zoological Society), universities (*e.g.*, University of Kiel), local institutions and societies (*e.g.*, Berlin Museum), and colleges (*e.g.*, South Dakota State College). Occasionally special committees have been founded for the express purpose of starting a biological station. These have been international (*e.g.*, Jungfraujoch Scientific Station), national (*e.g.*, Freshwater Biological Association of the British Empire), and local (*e.g.*, Liverpool Biological Committee).

More than one-half of the stations in the United States have been established by universities or colleges. There is apparently a world-wide trend away from the foundation of these institutions by private individuals. This might be explained by the fact that the organization of a field station involves greater expenses than formerly, when an individual scientist with a few students, much enthusiasm, and little equipment could establish a station or induce a rich patron to finance one.

Their Development. — Once a station is founded, it is naturally often not equipped to cope with all the problems which it often must face. Several stations have experienced considerable delay between the time they were started and the time their instruction or research program was begun. And being very dependent upon the immediate natural environment, some stations have had to move from their original sites, because of the unfortunate choice of the original site or because of the encroachment of civilization.

Their Abandonment. — Biological stations have been abandoned for a number of reasons. The most common causes for discontinuance have been the death of the founder or director (*e.g.*, LOUIS AGASSIZ's death soon brought an end to the Anderson School of Natural History), fire (*e.g.*, Cornell University Biological Station), marine disaster (*e.g.*, the wreckage

of the *Pourquoi Pas?*), war (*e.g.*, Royal Hungarian Marine Biological Station), curtailment of funds (*e.g.*, The Biological Station of the United States Bureau of Fisheries at Woods Hole), and personal disagreements (*e.g.*, Mountain Laboratory of the University of Utah).

Since the first biological station was founded, at least ninety of these institutions — approximately one out of four established — have gone out of existence. The life span of abandoned stations has varied widely. One institution (*i.e.*, The Biological Station of the United States Bureau of Fisheries at Woods Hole) closed after being in operation fifty-one years. Others (*e.g.*, Lake Cooper Biological Laboratory) have closed their doors after one season. The average length of life of the abandoned stations has been about sixteen years. The average length of life of those stations existing in 1940 was about twenty-six years, with the oldest founded in 1859 and the youngest founded in 1940.

References:— (1) Revue Scientifique 70:750-53, 1932. — (2) U. S. Bur. Educ. Bull. 1910(4):1-360, 1910. — (3) Rev. Univ. Bruxelles 3:23-47, 121-51, 203-35, 1898. — (4) Revue Scientifique, *op. cit.* — (5) U. S. Bur. Educ. Bull., *op. cit.* — (6) *cf.* Harper's Weekly 17:701-02. Popular Science Monthly 40:721-29. Nation 17:174-75. *Ibid.* 31:29. American Naturalist 32:189-96. Nature 6:34. *Ibid.* 8:454-55. *Ibid.* 11:167-68. *Ibid.* 21:497-99. *Ibid.* 31:174-75. Science 58:273-75. Literary Digest 79:68-69. New York Daily Tribune, March 12, 1873. *Ibid.* March 27, 1873. *Ibid.* July 9, 1873. *Ibid.* July 10, 1873. New York Times, March 27, 1873. *Ibid.* April 23, 1873. *Ibid.* May 22, 1873. FRANK R. LILLIE: The Woods Hole Marine Biological Laboratory. University of Chicago Press, pp. 15-23, 1944. Sci. Mon. 62:315-21.

The Location of Biological Stations: — The uniqueness of biological field stations lies in their location, in the opportunities they offer students and investigators to study biological forms at close range in their natural environment. While political, geographical, and other considerations enter into the establishment of biological stations, these institutions are usually located on sites near or within a unique biological environment, or else in an area where an abundance and variety of biological forms are easily accessible. Some believe the ideal to be an itinerant station or a "floating station," which provides more freedom to move to new sites frequently or periodically. Similar results in extending the working radius of a station have been obtained by establishing annexes or by removing a whole station to a new site after a period of years.

Ecological Location. — About one-half of the stations of the world are marine biological stations. The remaining ones are about evenly divided between being primarily situated for work in fresh-water biology and in terrestrial biology. While biological stations have penetrated the arctic (*e.g.*, Greenland), the desert (*e.g.*, Morocco), and the jungle (*e.g.*, Panama), there are many biological areas in the world possessing none of these institutions. Professor T. W. VAUGHAN has pointed out the "paucity of oceanographic stations south of the equator"[1]. Some of the larger areas without biological stations include Lake Victoria, the Caspian Sea, the Himalaya Mountains, the Andes Mountains, the tropical forests of Africa and South America, the prairies of Patagonia, the steppes of Tibet, and the deserts of Mongolia.

Political Location. — The estimated 265 biological stations in operation in 1940 were distributed in fifty-eight political divisions. The United States led in the number of existing field stations with sixty-three. Other

countries with a relatively large number of biological stations include the U. S. S. R. with twenty-three, France with twenty, Germany with fourteen, Japan with twelve, and Italy with ten. There are also a number of countries which, in 1940, had no biological stations within their borders. These include Turkey, Greece, Ethiopia, Iceland, and New Guinea.

There is little or no correlation between the population or size of a country and the number of biological stations it supports. Switzerland, for example, has one field station for about every 2,600 square miles of its territory, while Brazil has but one station for every 1,000,000 square miles of its land. For the political areas which have field stations, the mean figure is one station for about every 28,000 square miles. The number of inhabitants theoretically supporting a biological station also varies greatly. Every 400,000 persons in the Mountain States of the United States support a biological station in that territory. In China, on the other hand, there is only one station for every 140,000,000 inhabitants. The mean figure (for those areas having these institutions) is one station for about every 3,000,000 persons.

The greater the number of biological stations a country supports, the greater theoretical support that nation gives to biology. Such might be true if biological stations were of the same size and had approximately the same scientific output. When, however, the actual factor of size or output is considered, a country like Hungary with only one biological station is perhaps supporting more field biological research and instruction than Czechoslovakia with six of these institutions. Traditionally, some countries have followed a conscious or unconscious policy of dissipating their resources by establishing a number of small stations rather than fewer big ones. Professor HENRI LACAZE-DUTHIERS warned in the last century, "we have been able to count as many as seventeen or eighteen stations on our coasts [France] in the course of 1891. . . Is this not also an exaggeration and a dissipation of precious energies which, if concentrated into a single strong organization, might render very great service?"[2].

References: — (1) International Aspects of Oceanography. Washington: National Academy of Sciences. 1937. — (2) Arch. Zool. 2(9):255-363, 1891.

The Administration of Biological Stations: — Biological stations are sponsored by several types of organizations and institutions. They are organized usually as separate administrative units of the institution or organization which sponsor them. A director is generally appointed by the sponsoring committee to manage the work of the station. While the director's duties are concerned primarily with all the problems attendant to translating into action the educational and scientific philosophy of the institution, the two administrative problems with which most station directors are especially occupied are balancing the station's budget and giving the station the kind of publicity which will make the desired number of students and investigators attend the institution each session.

Sponsorship. — Biological stations usually have not sufficient financial strength to be autonomous institutions. Although separate administrative units, they are sponsored by various types of organizations and individuals. Universities and colleges appear to be the most frequent sponsors of con-

temporary biological stations. More than one-half of the stations in the United States are so supported. Scientific institutions and organizations less frequently play the role of sponsors of biological stations (*e.g.*, The Royal Society of Göteborg supports the Oceanographic Institute of Göteborg, Sweden). Governmental departments are also the sponsors of biological stations (*e.g.*, the Egyptian Ministry of Commerce and Industry supports the Fouad I Institute of Hydrobiology and Fisheries at Alexandria). In some cases, several types of organizations combine to support a biological station (*e.g.*, The Laboratory of Zoology of the University of Iaşi and the Ministry of National Education together sponsor the Marine Zoological Station "King Ferdinand I" at Agigea, Roumania). A few of these institutions are sponsored by private individuals (*e.g.*, Dr. FRIEDRICH MORTON is the sole supporter of the Botanical Station at Hallstatt, Austria). Lastly, about one-tenth of the biological stations are autonomous, being sponsored by an organization formed specially for that purpose (*e.g.*, The Bermuda Biological Station for Research is an institution founded and incorporated for the sole purpose of supporting its own scientific work)[1].

Organization. — Most biological stations are organized as more or less autonomous departments of the organizations or institutions which sponsor them. The parent institution usually appoints a kind of executive committee which in turn appoints a director in whom is vested most of the administrative duties. Those stations which are truly autonomous institutions often present the greatest administrative problems because they have no sponsoring institutions after which to pattern their organization and with which to integrate their functions. They often find it best to have a formal board of trustees. The executive committees or boards of trustees of the larger stations issue annual reports of the work of the institution. While most often they are summaries of research (*e.g.*, Report of the Reelfoot Lake Biological Station), occasionally they are administrative summaries (*e.g.*, Report of the Marine Biological Laboratory, Woods Hole, Mass.).

Directors. — The bulk of the administrative work of most biological stations falls upon the directors of these institutions. They are usually appointed to these positions by the executive committee or the board of trustees. Not infrequently in the case of younger stations, the directors have assumed their positions by being the founders of the institution (*e.g.*, ANTON DOHRN, founder and first director of the Zoological Station of Naples). About one-quarter of the directorships are full-time positions. Most of the stations, however, are in operation only a portion of the calendar year and consequently these positions are part-time ones. During the greater part of the academic year, the directors are usually university or college professors, although their vocations vary from that of a superintendent of schools to a drug store proprietor. In any case, the directors are scientists, most often, zoologists.

Finances. — The financial problems facing the directors of biological stations are those facing most other institutions: how to obtain an adequate income and how to spend it wisely. Biological stations obtain the largest share of their income from the services they render in providing facilities for research and instruction to investigators and students. Even so, most

of these institutions are unable to meet their expenses through tuition and laboratory fees and must turn to supplementary sources of income. These include income from their sponsoring organizations (in the form of direct subsidies), from the government (for scientific services), and from the public (for admission to aquariums). Autonomous institutions must seek even a wider source of income which often include outright government grants, endowments, the sale of biological specimens, and membership and patron fees. Once acquired, the income of biological stations is expended on administration, instruction, research, and the maintenance and operation of laboratory and living facilities.

The actual budgets of biological stations vary with their purpose, size, and age. The Marine Biological Laboratory has had the largest budget: $185,096 in 1938. Several of these institutions, on the other hand, have annual budgets of less than one thousand American dollars (*e.g.*, Biological Laboratory of Lake Orédon, France, has an annual budget of 4,000 francs or $106). Any attempt at obtaining an average budget is meaningless because of the varying currencies, standards of living, and even accounting practices. It is worth noting, perhaps, that England has an average yearly budget of $28,470 per station, whereas Italy has an average annual budget of $421 per station (excluding the international Zoological Station of Naples). The average annual budget of one-half of the existing United States stations is $21,130.

Publicity. — Since the financial success of most biological stations is very much dependent upon the attendance of a full quota of students and/or investigators, various publicity practices have been devised to attract these students and investigators. In the United States, it has been the custom for most of these institutions to issue annual announcements of their available facilities. About three-quarters of the United States stations publish such announcements. They may vary from a one-page mimeographed sheet (*e.g.*, the 1940 announcement of the San Francisco State College Science Field Session) to a 35-page booklet (*i.e.*, 1940 announcement of the Marine Biological Laboratory). The stations in the United States which do not issue annual announcements are either in the early stages of existence or offer only research facilities, in which case a detailed printed announcement may serve for several years. Several of the American stations supplement the publicity given in their annual announcements by inserting news notices in the unpaid columns of certain scientific journals (*e.g.*, *Science*) or paid advertisements in others (*e.g.*, *Nature Magazine*). In Europe, station announcements more often take the form of one-page brochures, printed annually and describing the current offerings in instruction or research. These are often supplemented by printed rules and regulations which are issued irregularly.

Directors of biological stations often obtain general publicity for their institutions by cooperating in the production of general articles about the work of the station in popular publications (*e.g.*, Machete Trails by DALLAS L. SHARP in *The Atlantic Monthly* in 1930). They also coöperate in the compilation of directories of the biological stations of a political or geographical area (*e.g.*, the 1937 issue of *The Biologist* [Phi Sigma Society] devoted to Biological Summer Schools). The most effective kind of publicity for

the biological stations of all countries results from the unqualified satisfaction and enthusiasm of students and investigators who have attended these institutions. Some stations have attempted to sustain this enthusiasm by organizing loosely-formed alumni associations with irregular meetings and newsletters.

Note: — (1) LILLIE shows the advantage of autonomous organization in "freedom from all restrictions of local institutional control." *Cf.* FRANK R. LILLIE: The Woods Hole Marine Biological Laboratory. University of Chicago Press, p. iii, 1944.

The Equipment of Biological Stations: — The kind of equipment with which a biological station is able to carry out its program depends upon its purposes and its resources, to a lesser extent upon its ecological and political location. Most biological stations have some sort of campus on which are constructed one or more buildings. These are equipped with laboratories and scientific apparatus for instruction and research. In addition, these institutions are also equipped to furnish board and lodging for those in attendance. There are a few itinerant stations which often have the same problems and needs of the stationary institutions and therefore have much of the same equipment, except a permanent campus and buildings.

Buildings. — In planning the laboratory buildings for the Anderson School of Natural History, LOUIS AGASSIZ stated, "I was determined that we should not be satisfied with that mode of proceeding of which we have so many examples in these medieval castles for the abode of modern science. I wanted, if possible, that our rooms should correspond at once with our work"[1]. While most directors have perhaps had this philosophy of planning, they usually have not had the financial opportunity to put such architectural theories into practice in establishing or even subsequently enlarging these institutions. Several stations have started and often continued in buildings erected for other purposes: the Murman Biological Station in a monastery, the Oregon Institute of Marine Biology in an abandoned Civilian Conservation Corps camp, the Zoological Station at Villefranche in an abandoned coaling station, the Hydrobiological Section of the Scientific Institute of Peterhof in an appropriated country estate, and the Laboratory of the Fresh-water Biological Association at Ambleside, England, in veritably a medieval-looking castle.

The size of biological stations is not usually proportionate to the number of buildings, but rather to what they contain. Thus the Zoological Station of Naples is housed in one building whereas the smaller Allegany School of Natural History maintained forty-seven building units. In general, biological stations can be classified into small, medium, and large plants. The smallest number of stations have relatively large plants. The ten top-ranking institutions in regard to the size of their physical plants probably would include, though not necessarily in the order given, those stations at Woods Hole (Marine Biological Laboratory), Naples, Plymouth, Helgoland, Woods Hole (Woods Hole Oceanographic Institution), La Jolla, Friday Harbor (and Seattle), Monaco, Roscoff, and Cold Spring Harbor. All except the last-named institution happen to be chiefly equipped for marine research. The largest inland biological stations would probably include those at Douglas Lake, Michigan; Put-in-Bay, Ohio; Lunz, Austria; and Jungfraujoch, Switzerland.

Laboratories and Apparatus. — Whatever their size, biological stations contain various types of laboratories and rooms equipped with apparatus with which to carry on their different functions. Increasingly this apparatus has become more complicated than the original equipment of the early field stations. Today even small stations are supplied with fairly intricate apparatus which never enters the field in the sense that it never leaves the laboratory.

The laboratories and apparatus of biological stations serve primarily for general research and instruction. In addition, a number of these institutions are also equipped for research in special fields, for photography, for collecting, for repairing, and for distributing supplies. The other functions for which many biological stations are equipped include public education, miscellaneous services, and library work.

Apparatus for General Biological Research. — Most field stations, even if they have no laboratories equipped for special functions, do have at least one room equipped for general biological research. Such equipment includes laboratory furniture, common chemicals and glassware, running fresh-water (and often sea-water), small aquariums or terrariums, electricity, and occasionally gas, compressed air, and vacuum pipes.

Those stations which have piped sea-water usually take precautions to insure the purity of the water, both at its source and during its conduct through pipes to the desk of the student or investigator. As Professor Kofoid observed, "much may be done by sedimentation and by preliminary storage in the dark to improve polluted waters for circulation in aquaria and laboratories; but, after all is said, purity of water supply is the greatest asset of the marine station"[2]. At least one station (*i.e.,* Bergen Museums Biological Station) has had to change its site because of the contamination of the waters adjacent to its original location. Another institution (*i.e.,* Oceanographic Institute of Göteborg, Sweden), desiring a certain type of sea-water, obtains it by freighter from the Bay of Biscay.

Apparatus for Instruction. — The nature of the instruction offered at biological stations is usually such to necessitate only the minimum of instructional apparatus. For those courses demanding inside laboratory work, class rooms and laboratories have to be provided. These often contain the apparatus furnished to the general research laboratories. In addition, they are often equipped with blackboards, charts, and microscopes. A few stations have special lecture rooms, although at most of these institutions, the lectures — if any — are of an informal nature, being often given in the laboratory or during a field trip.

Apparatus for Special Services. — Laboratory apparatus is often supplied for research in various special fields of science. While these fields vacillate with the trends in biology, the more common ones are bio-chemistry, physiology, and taxonomy. Other subjects for which one or more biological stations are especially equipped include bio-physics, economic fisheries, hydrography, bacteriology, and microscopy.

Photography is an important aid to field instruction and research. Most biological stations are equipped with rooms to develop and print photographic negatives. While most stations usually have only one darkroom,

the larger institutions often have several which are well-equipped with developing and printing apparatus.

Since the collection of scientific specimens has increasingly become an art, complicated equipment and even highly-trained personnel are needed. Many stations maintain boats and automobiles for collecting purposes. The boats vary greatly in number and size. Some stations use and need only rowboats and canoes. Others have large vessels, such as the 112-foot *Makrele* of the Biological Station of Helgoland. A few boats have been specially-built for scientific work, such as *The Atlantis*[3] of the Woods Hole Oceanographic Institution[4]. Stations which do have boats must have places to keep them and often employees to run them. In addition to operating boats, the stations which do a large amount of collecting must have employees who, if not formally-trained scientists, must know enough practical biology to be able to go out in the station's vessel and find the various biological forms that are wanted. One of the most famous of such collectors was SALVATORE LO BIANCO who for many years was conservator of the Zoological Station of Naples.

As scientific apparatus is used at biological stations — as elsewhere — it needs adjustment, becomes broken, or wears out. At institutions situated in isolated places or at the larger ones, it is often expedient for the station itself to attempt to adjust, repair, or make research apparatus. To meet these needs, several stations have well-equipped shops for machine-work, carpentry, and glass-blowing.

Most stations have had to be equipped for the distribution of scientific apparatus and supplies to those in attendance. Equipment for this purpose at the larger institutions includes stock rooms, station stores, and, in several instances, whole departments for the sale of live and preserved biological forms.

Apparatus for Public Education. — The public education attempted by biological stations is usually by means of aquariums, museums, and botanical gardens. The more ambitious of each of these projects demands elaborate equipment and personnel. The aquariums vary in size from small, one-room exhibits in table tanks to very large installations as at the stations at Naples, Helgoland, and Monaco. Public museums also are often operated in conjunction with the marine aquariums (*e.g.*, Monaco). Botanical gardens are maintained by several stations. While they do not entail much equipment, they usually require the services of several gardeners and laborers to give them the constant care required for their successful operation.

Apparatus for Miscellaneous Services. — One of the auxiliary functions of field stations is the securing of regular hydrographic and meteorological observations, often in coöperation with other agencies (*e.g.*, the Weather Bureau and the Coast Guard in the United States). The equipment necessary to take these observations varies from simple thermometers and rain gauges to tidal stations and apparatus for measuring direct and diffuse solar radiation (*e.g.*, Oceanographic Laboratories of the University of Washington).

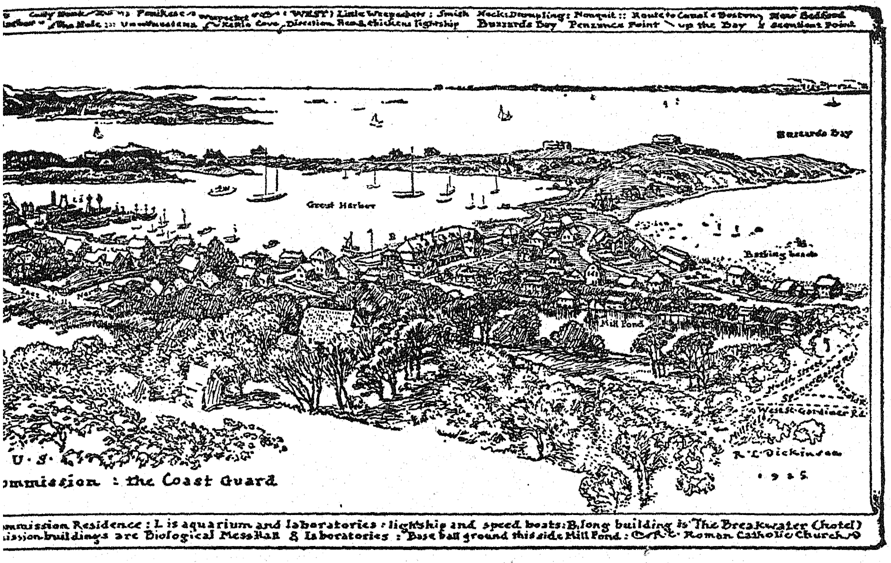
Other functions for which many biological stations must be equipped are administration and transportation. While much of the administrative work in connection with the conduct of biological stations is often carried

A VIEW OF THE LABORATORIES AT WOODS HOLE, CAPE CCHUSETT

on at the offices of the sponsoring institutions, many need some kind of office and secretarial aid in the field. Likewise, while individuals often provide their own transportation to biological stations, these institutions must often provide transportation for classes and supplies. This is done by means of various types of boats and automobiles. While most stations in the United States have one or more automobiles, only a few institutions in Europe or elsewhere have such vehicles.

Library Facilities. — Most biological stations have some kind of library. The type varies with the purposes of the institution and the actual use to which the library is put. Some of the smaller institutions have a very small, yet adequate, collection of taxonomic manuals and reprints. Other stations have rather complete libraries on special subjects (*e.g.,* the bryological library of the Summer School of Bryology). A few stations have large libraries with bound volumes, reference books, reprints, and current serial publications on a number of biological subjects. Such collections require much equipment and the services of full-time librarians. The largest library operated by any biological station is that of the Marine Biological Laboratory. It ranks as one of the best libraries of scientific serial publications in the world.[5]

Itinerant Stations. — While not possessing fixed campuses or buildings, itinerant institutions nevertheless require the other necessary equipment for biological stations. Certain peculiar equipment of itinerant institutions include boats for the aquatic ones (*e.g.,* the ill-fated *Pourquoi Pas?*) and trucks, automobile caravans, and buses for the terrestrial ones (*e.g.,* Animal Ecology Field Trip of the University of Illinois). Cumbersome libraries and heavy apparatus are usually not maintained by these stations, although otherwise they possess the regular equipment necessary to care for the laboratory and living needs of their students, investigators, and faculty members.



s (ca. 1925), *after an etching by R. L. Dickinson.*

References and Notes:— (1) New York Daily Tribune, July 9, 1873. — (2) U. S. Bur. Educ. Bull. 1910 (4) :1-360, 1910. — (3) *cf.* annual announcement of this institution for a detailed description of this vessel. — (4) Other vessels over 100 feet in length attached to biological stations include *De Lanessan* (Cauda, French Indo-China), *Mabahiss* (Alexandria, Egypt), *Africana* (Sea Point, Union of South Africa), *E. W. Scripps* (La Jolla, California). — (5) It contains 6,000 bound volumes, 52,000 bound serial publications, 1,300 current serial publications, and 130,000 reprints. *Cf.* FRANK R. LILLIE: The Woods Hole Marine Biological Laboratory. University of Chicago Press, pp. 100-05, 1944.

The Living Facilities at Biological Stations: — A majority of biological stations offer living facilities to their students, investigators, and staff members in addition to opportunities for research and instruction. Some of the early field stations did not concern themselves with the board and lodging needs of those in attendance, often because these were available in nearby towns. The Zoological Station of Naples, for example, has never made an attempt to provide living facilities, other than a noonday meal. As these institutions, however, began to be established in environments removed from centers of population, their managements were forced to provide living accommodations. From the inclusion of these facilities at some stations because of sheer necessity arose their inclusion at others because of saving both time and money of the students attending them. Also the value of maintaining living facilities was recognized as making for a closely-integrated scientific community[1]. For a physiologist to live in the same dormitory as a taxonomist was liberalizing. Equally broadening was the student's being able to eat at the same table with the faculty member.

From providing board and lodging, some stations soon extended their offerings to medical service and organized recreation. Today, therefore, a great many biological stations are prepared to offer those in attendance much more than a laboratory desk and a rowboat. That these facilities exist and often entail great administrative problems and expenses do not detract from the purpose of biological stations. Indeed, living facilities are furnished so that a student or investigator may better be able to fulfill the

purpose of the institution, may better be able to use that laboratory desk and rowboat.

Board. — Somewhat less than one-half of the field stations of the world offer boarding accommodations to those in attendance. This proportion often varies with the political area in which the station is located. Countries which have a high proportion of their stations offering dining accommodations include Japan, Canada, and the United States. Those countries which have a low proportion of their field stations offering boarding accommodations include Italy, Germany, France, and Sweden.

The equipment which these institutions require to prepare and serve meals varies both with the resources and needs of the stations and occasionally with the customs of the country in which they are located. The larger stations in the United States have separate dining buildings with mechanically-equipped kitchens. The itinerant field stations, on the other hand, have portable cooking apparatus. One of these stations (*i.e.*, West Virginia University Biological Expedition) has a kitchen on wheels.

The administration of the boarding facilities at these institutions is usually vested with the director of the station. In a few instances it is leased to a concessionnaire or, in small European stations, relegated to the *concierge* who is paid directly by the student or investigator. At several American stations board is offered on a coöperative basis: the students, investigators, and faculty members who receive board determine the policies of the commissary department.

Several biological stations offer equipment for students and investigators to prepare their own meals. In some instances, the students are expected to coöperate in preparing the meals. At other stations the students or investigators are expected to buy their own food and prepare it separately. The Marine Biological Station of Fouad I University in Egypt is unique in that the investigator shares in the services of a cook and houseboy (*farrash*), although he is expected to buy the unprepared food at a nearby canteen.

The biological stations which do not provide board or facilities for individuals to prepare their own are usually located within walking distance of places where meals can be obtained. Indeed, several American stations have established their headquarters in hotels where students are expected to obtain board.

Lodging. — About two-thirds of the biological stations of the world offer lodging accommodations. Almost all of the institutions which offer boarding facilities also offer lodging. In addition, one-fifth of the stations of the world which are not equipped to serve meals are equipped with sleeping arrangements. The countries which rank high in the proportion of field stations within their borders offering lodging facilities include Roumania, the Netherlands, Japan, Canada, United States, Sweden, and France. Those countries with a low proportion of their stations providing room include Algeria, Denmark, Italy, and Switzerland.

The equipment which these institutions require to lodge those in attendance varies both with the individual station and with the standard of living for the country in which it is located. In the United States, lodging accommodations range from the large dormitories of the Marine Biological Labo-

ratory with running hot and cold water in many rooms to the few supplies needed for the students to spend the nights in a sleeping bag at the Pacific Union College Field Nature School. Many of the stations in the United States maintain attractive cabins or sometimes tents for two or three persons each. In Europe, the lodging accommodations at most field stations are in the same buildings as the laboratory work, although at several stations (*e.g.,* Zoological Station of the Netherlands Zoological Society) special structures for lodging have been erected.

The maximum number of persons who can obtain lodging accommodations at a station ranges from 275 at the Marine Biological Laboratory to less than five (*e.g.,* Biological Station of Wijster). The biological stations which are prepared to care for the lodging needs of a large number of students and investigators include, in addition to the Marine Biological Laboratory, the Biological Station of the University of Michigan (with accommodations for 200 persons) and the Lake Itasca Forestry and Biological Station (with accommodations for 100).

The biological stations which do not provide lodging are usually located near places where it may be obtained. The Lake Geneva School of Natural Science, for example, is located on the grounds of College Camp, an enterprise which furnishes lodging and board. The Oceanographic Museum and Aquarium at Monaco, although offering no lodging facilities, is located near a number of *pensions* and hotels where the investigator may obtain rooms within a wide price range.

Cost of Living Accommodations.— The biological stations which offer both board and lodging usually charge one sum for both of these services. This amount varies for stations within a given country and for those in different countries. The highest cost is $28.00 a week for room and board (*i.e.,* Barro Colorado Island Biological Laboratory) and the lowest cost is the equivalent of $1.34 a week at the Marine Biological Station of the Tôhôku Imperial University in Japan. The average cost per week for board and lodging at fifty-eight stations is $9.00.

Those field stations which charge relatively high prices for board and lodging usually are, 1, in remote areas where food acceptable to foreigners is relatively costly (*e.g.,* $28.00 a week at the Barro Colorado Island Biological Laboratory in Panama); 2, in countries where the cost of living is normally high (*e.g.,* $15.21 a week at the Bermuda Biological Station for Research, Inc.); or 3, in countries with an unfavorable rate of exchange with the American dollar or British pound (*e.g.,* $16.85 a week at the Biological Station of Helgoland). In the United States, the reasons for the high costs of board and lodging at some stations are either their location in relatively remote areas (*e.g.,* $14.00 a week at the Science Summer Camp of the University of Wyoming) or their location in parts of the country where living costs are usually high (*e.g.,* $10.50 a week at the Biological Laboratory of the Long Island Biological Association).

Health and Recreation.— Community hygiene is only considered a factor of importance at those biological stations which have a large number of students and investigators in attendance. Most of the institutions outside the United States have shown no special regard for the health of their students or investigators, except in the case of tropical countries where this

is more essential. The greatest care for the health of students and investigators at any of these institutions has been taken at the Biological Station of the University of Michigan. Here a physician is in residence to provide medical service if the need should arise. He also supervises general camp sanitation. A one-room hospital is also available at this station for any person who may need temporary medical detention.

Many of the biological stations in the United States and a few of those in other parts of the world provide organized recreational facilities for persons in attendance. In most cases the recreation is in charge of the director, often assisted by staff members and students. Excursions, picnics, campfires, and dances are some of the recreational activities offered. One of the results of the organized recreational activities at biological stations has been the growth of a series of songs, either about life at the station or about the biological forms studied.

Another result of the announced recreational activities at biological stations (together with their location) is that some students, especially in the United States, attend these institutions as much for a vacation as for the instruction they will obtain. While the recreational activities at some stations do attract vacationists, those institutions which are sensitive to the recreational needs of students and investigators do not have the frequent problem of a general exodus of students from the station to a nearby town each week-end in search of amusement.

Note: — (1) An appreciation of the contribution of community life to the scientific program of the Marine Biological Laboratory is given by E. G. Conklin and Frank R. Lillie in the latter's The Woods Hole Marine Biological Laboratory. University of Chicago Press, pp. 170-76, 1944.

Instruction at Biological Stations: — One of the primary purposes for the operation of biological stations is the field instruction they offer. More than one-half of the contemporary field stations offer some kind of formal instruction in the biological sciences and related subjects to beginning and advanced students. A number of these institutions also conceive within the scope of their activity various kinds of public education, such as the maintenance of public aquariums and museums.

Those field stations which offer formal instruction are of two types: the so-called typical biological station which is equipped to offer both instruction and research, and the biological nature camp which is devoted almost wholly to instruction. In giving instruction, both kinds of institutions must solve certain problems attendant to the course work, in addition to those of equipment and living facilities. They must secure an adequate staff of instructors. They must evolve an educational philosophy to decide the course work to be given and the organization of the actual teaching. They must decide on the actual courses to be offered. They must solve a series of administrative problems related to curriculum practices, academic credit, tuition, and scholarships. Lastly, they must occasionally analyze the students they attract in order to compare the product of instruction with the aims of instruction.

The Teaching Faculty. — About 350 persons are engaged in teaching activities at the various biological stations each year. While some of these institutions have only one faculty member (*e.g.,* Summer School of Bry-

ology), the Marine Biological Laboratory has twenty-six. The average number of faculty members for those stations which do have formal instruction is between three and four.

Education, Academic Position, and Specialization. — Three out of four faculty members of biological stations in continental United States have their doctor's degree, and this figure is higher for those faculty members at the field stations of most other countries. A few stations have no faculty members with doctorates (*e.g.*, Lake Enemy Swim Biological Station), while the entire faculty of several of the larger field stations do have their doctor's degrees (*e.g.*, Scripps Institution of Oceanography).

The majority of faculty members are university professors, although their occupations during the period of the year in which the station is not in session vary from that of a retired high school teacher (*i.e.*, Dr. A. J. Grout of the Summer School of Bryology) to a United States National Park Naturalist (*i.e.*, C. A. Harwell of the Yosemite School of Field Natural History).

The majority of the faculty members of biological stations are zoologists. Among the fields of specialization other than general zoology, botany, and biology of the faculty members may be included oceanography, nature education, geology, meteorology, and astronomy.

Institutional Inbreeding and Faculty Turn-over. — During the regular academic year a large proportion of the faculty at biological stations is attached to the institution which sponsors the station. This is a type of institutional inbreeding. In the United States, this practice varies from one hundred per cent (*i.e.*, Oceanographic Laboratories of the University of Washington) to none, especially in those field stations which are autonomous and therefore do not have parent institutions. While it is often easier for a field station to employ faculty members attached to its sponsoring institution, a more qualified staff can often be obtained at least partially from outside institutions.

In order to prevent complete inbreeding of their faculty, several of the biological stations of the United States make a practice of employing instructors from outside institutions for one or several seasons. One station with eleven faculty positions has had seven of these filled by different persons in a space of four years. Another station (*i.e.*, Michigan State College School of Field Biology) with a faculty of three, has not had a change in its staff for a period of eleven years.

A frequent change of faculty members does not usually increase the quality of instruction, even though it may bring in a new point of view for a time. Some of the best instruction at these institutions is given by those persons who have taught at one station for many years, since most field instruction demands as much knowledge of the particular environment around the station as of the subject-matter itself. Yet while a slow faculty turn-over is a definite asset to the quality of instruction at many of these institutions, continuous teaching at any one station might retard the scientific progress of a particular instructor. This whole problem of faculty turn-over is one which few stations have answered successfully. One method of solving this problem has been the granting of a periodic leave of absence to

the instructor and then keeping his position on the staff unfilled for the period he is absent from the station.

Teaching Load. — It is not easy to calculate the average teaching load of faculty members while in residence at biological stations because the teaching load is a function of the instructor's philosophy and method as well as of the actual number of students, courses, or credits for which he is held responsible. Of forty-nine United States stations, each faculty member in general is responsible for about seventeen students, although this varies from almost six students for each faculty member of the Marine Biological Laboratory to a theoretical number of sixty students for the one faculty member of the Laguna Beach Marine Laboratory.

The average number of courses each faculty member teaches is often a better criterion of teaching load than the average number of students, because course enrollments differ as widely within field stations as within colleges or universities. At the typical field station the instructor is responsible for teaching one course which, in the United States, averages between four and five academic credit hours of work. This figure varies from one-fifth of a course for each instructor (*i.e.*, New Hampshire Nature Camp) to three courses for the instructor (*i.e.*, Merriconn Biological Laboratory).

The average teaching load of most faculty members at field stations is such that they spend more than one-half of their time in teaching. The remainder of their time is spent in their own research or in supervising the investigations of advanced students. Most of the faculty members of American stations bring their wives and children with them to live at the station and they spend, therefore, a portion of their time with their families.

Educational Philosophy. — Once a biological field station has decided to offer formal instruction, it must next evolve an educational philosophy to determine the type of course work that it will give. Field stations have, in general, followed one of two educational philosophies, although the majority of stations offering formal instruction combine the two concepts as much as they are able.

One type of station has adhered to an educational philosophy of offering only advanced instruction, especially for persons preparing to receive advanced degrees or to become research investigators. While the Marine Biological Laboratory is perhaps the outstanding example of such an institution, at least twenty-five other stations adhere to this policy.

The opposite practice is that held by the biological stations which believe that field instruction should be of an elementary nature. This type of station, of which almost all are in the United States, offers only elementary courses for public school teachers and undergraduate students who have neither the desire nor the training for extreme specialization.

That both philosophies of instruction at biological stations have a legitimate appeal may be seen from the fact that more than one-half of the biological stations of the world which do offer instruction are prepared to give courses both to elementary and to advanced students. And in actual practice, the instruction at biological stations is not only determined by their educational philosophy, but also by their location, the instructors available, and the potential student-body.

Advanced Instruction.—The biological stations which offer only advanced course work are located from Finland to Algeria, from Maine to the southern part of California. The actual course-work offered by these institutions is often of a very advanced nature (*e.g.,* advanced invertebrate embryology at the Oceanographic Laboratories of the University of Washington), although several are intermediate courses and may be taken with only one previous course in the biological sciences (*e.g.,* entomology at the University of Michigan Biological Station). The biological stations which offer only advanced instruction may often be distinguished more by their admission requirements than by the courses they offer. Graduate and occasionally upper-class undergraduate students are admitted to these institutions. Yet even students of these ranks may take certain courses only after fulfilling certain prerequisites.

Elementary Instruction.—At least eighteen biological stations offer only elementary instruction. These institutions are, with the exception of the Helgoland Bird Observatory, located in the United States. The courses given at these institutions are usually in the fields of nature study and the pedagogical training of nature-study teachers. The requirements for admission to these institutions are minimal, for the purpose of instruction is generally to engender an appreciation and understanding of the outdoors by means of field trips and observations. Several institutions in this category are particularly interested in training special groups of persons, as teachers in nature study (*i.e.,* West Coast School of Nature Study) and leaders of nature recreation (*i.e.,* Virginia Natural History Institute Nature Leaders' Training Course).

Combined Instruction.—A majority of the biological stations which consider at least a portion of their function to be instruction offer course work to both advanced and elementary students. These institutions believe that both the beginning and advanced student may receive inspiration and instruction by being at the same biological station, if not actually attending the same courses. The actual courses at these stations vary from those of a very elementary nature (*e.g.,* man and the living world at the Isles of Shoals Marine Zoological Laboratory) to advanced ones with many hours of prerequisites (*e.g.,* parasitology at the Lake Itasca Forestry and Biological Station).

The requirements for admission to these biological stations which offer both elementary and advanced instruction are relatively flexible. In general, the requirements depend more upon the actual courses to be taken by the student, than by his general academic rank. Some of these stations (*e.g.,* Allegany School of Natural History) are open to "gifted high school students" and others (*e.g.,* Lake Itasca Forestry and Biological Station) are "open to all qualified graduate students who have had the usual preliminary courses in biological subjects." The purpose of the instruction given by institutions in this category also varies from fulfilling part of the science requirements of "pre-professional students, such as pre-medical, pre-dental" (*i.e.,* Isles of Shoals Marine Zoological Laboratory) to assisting "persons interested in the study, collection and determination of particular groups of animals and plants" (*i.e.,* Oregon Institute of Marine Biology).

The Courses. — About two hundred and fifty courses are given by those biological stations which offer some kind of formal instruction. Each institution offers an average of three courses a year, although the majority of stations give only one course. The American stations tend to offer more courses than those in other countries. One American station (*i.e.*, Lake Itasca Forestry and Biological Station), offers eighteen courses, while the largest number of courses given by a station located outside the United States is six (*i.e.*, Marine Biological Station of the Tôhôku Imperial University). Those stations offering only elementary instruction tend to give the fewest number of courses, while those which give only advanced instruction offer the greatest number of courses, perhaps because of the specialized needs and interests of advanced students.

Sciences Represented. — Most of the courses offered by biological stations are naturally in the biological sciences. While the largest number of courses are offered in zoology, the proportion varies from almost less than one-half for the stations in the United States to less than one-fifth for those institutions in other parts of the world. The inclusion of courses not within the traditional limits of zoology, botany, or biology indicates that these institutions fully realize the need of exploring, by instruction as well as research, the borderline fields between biology and the social sciences (*e.g.*, nature education) and biology and the physical sciences (*e.g.*, marine meteorology). Another need felt and realized at several stations is the integration of both the physical and biological sciences into one field course at an elementary level (*e.g.*, nature study).

A classified list of the general fields in which course-work is offered at one or more biological stations follows: protozoology, invertebrate zoology, helminthology, entomology, ichthyology, ornithology, vertebrate zoology, field zoology, animal ecology, economic zoology, parasitology, embryology, comparative anatomy, algology, mycology, bryology, taxonomy of higher plants, field botany, dendrology, plant ecology, plant physiology, plant anatomy, plant morphology, plant histology, limnology, marine biology, general ecology, general physiology, microbiology, wild life conservation, biochemistry, paleobiology, oceanography, nature study, nature education, geology, meteorology, chemistry, seismology, astronomy, and geography.

Types of Courses. — Instruction at biological stations probably first arose when college and university professors realized they could not teach successfully about marine life a hundred or thousand miles away from the sea. Instruction was first given at biological stations in subjects which could not be thoroughly or scientifically taught (*i.e.*, by observation and/or experimentation) in the ordinary college or university campus laboratory located often miles from a forest and even further from fairly uncontaminated seashore. Thus the first subjects to be taught at field stations were *1*, the taxonomy of biological forms, for the whole kingdom (*e.g.*, plant taxonomy), for a special area (*e.g.*, botany of the Alps), or for a special group (*e.g.*, bryology); and *2*, the ecology of biological forms, either for a whole kingdom (*e.g.*, animal ecology), or for special environments (*e.g.*, limnology).

As the research programs of biological stations became increasingly concerned with physiological problems, courses in physiology were given

at these institutions. At first these courses made good use of the living organisms in the field station environment. This departure, however, from the traditional type of course-work at field stations perhaps helped to lead to the initiation of a whole series of courses offered by these institutions which had less and less relation to the environment in which they were located. Courses such as cell morphology, experimental surgery, and histology-embryology appear in the catalogues of contemporary stations. Today students often go long distances to attend a field station which offers a course in a subject which may perhaps be better taught at a well-equipped university campus in the center of a large city.

There are several reasons for the introduction of these so-called "laboratory" courses at field stations. Some laboratory and lecture courses have been given frankly to attract a sufficient number of students to make the continuance of the station and especially of its field program possible. Such courses, for example, have often been for pre-medical students, the latter actually subsidizing the courses offered by the institution in the less popular "field" subjects. A second reason for the introduction of courses often unrelated to the station's biological environment is found in the station's research program. Several stations are avowedly more concerned with research than with instruction. The teaching they do offer is quite secondary and dependent upon both the station's research program and the staff members available as instructors. Thus the Biological Laboratory of the Long Island Biological Association offers a course in experimental endocrinology because it is one of the spheres of research upon which the laboratory has decided to concentrate; also, a member of this station's staff is perhaps more qualified to teach this subject than one more related to the environment in which the station is located. Other reasons for the offering of laboratory courses at field stations, in the words of station officials, are "we can get better work out of the student" and "there is a need for these courses and they are given nowhere else."

Another trend is the use, at some stations, of indoor laboratory methods even in field courses which may best perhaps be taught with so-called outdoor methods. Dr. Charles C. Adams once commented, "I have known of cases where the *field* school merely repeated the city class work, only using fresher material than in the city, and without the slightest idea that this was not a sane procedure"[1]. Such observations have caused some American biologists to believe that their students can often obtain better field instruction and experience from courses on several university campuses not too removed from "the field," than at some biological stations even in isolated places.

The Subject Matter.—While some courses offered by different biological stations may have the same titles, their subject matter often differs greatly. This divergence is most often due to the location of the station and to the training of the instructor, although the educational philosophy of both the station and instructor are important contributing factors. Because of their small classes, biological stations can be remarkably sensitive to the needs of their students. The courses given are often markedly altered once the instructor knows the wishes of the students actually registered in any course in a given year.

Administrative Problems. — The instruction at biological stations is most often organized into one, short session, beginning in June. Three-quarters of these institutions which give instruction offer it at only one session a year. Those stations which offer more than one session do so because of limited classroom facilities (*e.g.*, Zoological Station of the Netherlands Zoological Society), because of the desire to give instruction at different times of the year (*e.g.*, West Coast School of Nature Study), or in order to give instruction in different localities (*e.g.*, Oglebay Institute Nature Leaders Training School). The largest number of sessions is offered by the Audubon Nature Camp. This institution gives five two-week sessions each summer, the desire being to train a large number of students rather than to teach one-fifth the number five times as long.

The length of the sessions at biological stations ranges from one week to nine. Almost one-third of the sessions are two weeks in length, while about one-fifth are for a six-week period. The shortest sessions are usually conducted by nature camps, while the longest ones are at those stations offering only advanced instruction.

The time of the year when instruction is given at biological stations depends upon a number of factors, of which the flora and fauna, the students, and the faculty are most important. Instruction can only be given at those times of year when the desired animal and plant forms can be adequately studied in the field. Instruction in alpine botany, for example, can usually not begin before July in the Alps, whereas marine biology may best be studied along New England during August. The time of the year when students and faculty members are normally free from their regular college or university studies limits instruction at biological stations to the summer vacation in the northern hemisphere. The stations in France and England, however, have long made a practice of offering courses during the universities' Easter recess in April. This is a time which is fairly favorable for the study of marine biology in those countries in Europe and it is also during the student's term at the university — an advantage because the student can closely relate the field biology learned at the station to the laboratory biology studied at the university. The West Coast School of Nature Study is the only institution in the United States which has recently attempted to give a session during the Easter recess.

June and July is the period of the year during which the greatest number of sessions is given. October is the latest month in the year that a course is offered at any biological station (*i.e.*, at the height of the autumn bird migration season a course in ornithology is given at the Rossitten Bird Observatory).

Academic Credit. — In biology as well as in most other subjects, contemporary university students, especially in the United States, not only take courses for the knowledge they receive, but also for the credit they may obtain toward an academic degree. For this reason biological stations have found it expedient to offer college credit for formal course work completed by students at these institutions.

In the United States, about four-fifths of the biological stations offering instruction have made arrangements for students satisfactorily completing course work to obtain credit. Those field stations which are directly spon-

sored by colleges and universities have the privilege of granting credit because of their connection to these institutions of higher learning. Biological stations which are sponsored by institutions other than colleges or universities, or are only partially sponsored by them, often make arrangements whereby work done at them is recognized by some nearby or affiliated college or university and is thus transferable to other such institutions throughout the country. Some autonomous field stations use similar procedures to obtain credit for their students. Ten field stations in the United States do not offer academic credit. These range from institutions which offer instruction of a very advanced nature (*e.g.*, Marine Biological Laboratory) to those stations where the instruction is very elementary (*e.g.*, Green Mountain Nature Camp).

Tuition and Scholarships. — Students are assessed tuition fees at most biological stations. These fees are usually for instruction, and sometimes include scientific supplies and transportation on field trips. The average tuition at forty-six biological stations is the equivalent of $28.82. Tuition costs range from $1.00 at the Nature Enjoyment Camp to $75.00 at the Marine Biological Laboratory. This variation is due to a number of factors, the most evident of which is the length of the session. A base for comparing the tuition is, therefore, that charged students per week. This ranges from $.35 weekly at the Zoological Station of Tvärminne to $14.25 weekly at Science of the Out-of-Doors. The average weekly tuition is $5.73, the amount being $4.57 for the ten stations outside the United States about which information on the cost of tuition is stated.

At least fourteen biological stations regularly charge no tuition fees. More than four-fifths of these are outside the United States. A number of stations in the United States, however, offer tuition scholarships for students who desire a diminution of fees either because of their scholastic excellence or financial distress. These scholarships are either offered directly by the administration of the station or by organizations interested in the work that the station is doing (*e.g.*, two partial scholarships for students at the Allegany School of Nature History have been provided by the Burroughs-Audubon Nature Club of Rochester, New York).

The Student Body. — Instruction is given at biological stations for the benefit of students who take the formal course work. The type of instruction offered is determined by the educational policy of the institution. At a number of the smaller stations, however, it has been expedient to determine this policy only after considering the desires of the potential and actual student body of the station. This has necessitated a systematic estimation if not an actual survey of the students who are attracted to each station. Another use made of such an estimate is to ascertain to what degree the student body, as the product of instruction of a station, compares with the educational aims or assumptions of the institution.

The student body at most biological stations is characterized by its heterogeneity. The students at any biological station, as at many other types of educational institutions, may be found to vary in their sex[2] and age, in their race[3] and nationality[4], in their training and occupation, and in their institutional connections. Thus persons enrolled in course work at many

larger stations include college professors and high school seniors, women interested in becoming nature counsellors and men training for research in theoretical science.

Public Education. — *Aquariums.* — In the nineteenth century, public aquariums were often associated in the public mind with biological stations. Even today thirty-four of these institutions maintain public aquariums. Many of these were built during the nineteenth century. While this tradition of maintaining aquariums associated with biological stations is strong in many parts of the world, it is not so in the United States. Only two United States biological stations possess these displays (*i.e.*, Scripps Institution of Oceanography and the Fisheries Biological Station at Beaufort, North Carolina).

While those biological stations which do have public aquariums are naturally concerned with public education, many incorporate aquariums into their function as a means of subsidizing the research work of the station. This plan was first conceived by Dr. ANTON DOHRN and today the number of visitors (and thus fees) received by the larger aquariums is substantial. The annual number of visitors to the aquariums of several large stations is as follows: 180,000 at Monaco in 1938, 73,260 at Helgoland in 1937, 40,000 at Naples in 1937, 43,045 at Port Erin in 1938, and 32,000 at Plymouth in 1937. To supplement the observations of the public at these larger aquariums, elaborate manuals describing the biological forms exhibited are often issued.

Museums. — These institutions are also occasionally sponsored by biological stations for public education. Most are marine museums associated with marine aquariums. Other types include museums of systematic biology (*e.g.*, The George M. Gray Museum of the Marine Biological Laboratory) and outdoor field museums (*e.g.*, Outdoor Museum of the Allegany School of Natural History).

Botanical Gardens. — Especially in alpine regions, botanical gardens are operated in conjunction with biological stations. Eleven stations have such public botanical gardens. In addition to alpine gardens, there are tropical gardens (*e.g.*, Foreigner's Laboratory at Buitenzorg) and Indian gardens and nature trails (*i.e.*, Allegany School of Natural History).

Public Lectures. — Laboratory tours and public lectures are sometimes included among the public education features of biological stations. The Allegany School of Natural History, for example, scheduled a series of popular evening lectures once each week during the period that it was in session. This attracted a number of interested persons from the vicinity. Visiting days are also inaugurated at these institutions, both as educational features and to concentrate visits (and thus limit distractions) from the public to one day of each session.

Notes:— (1) From a letter, dated March 25, 1940, to the author. — (2) Although most biological stations today admit women students, co-education was a debatable subject when these institutions were first established. LOUIS AGASSIZ, however, had no misgivings about allowing women to register as students in the Anderson School of Natural History. He once stated, "As soon as the number of students was limited, we determined a question of no small moment,—whether ladies should be admitted. In my mind I had no hesitation from the start. There were those about us whose opinion I had to care for but did not know, so I thought the best way was not to ask it, but

to decide for myself." *Cf.* American Naturalist 32:189-96, 1898.— (3) Both colored and white persons are generally admitted as students and investigators at biological stations. The late Dr. ERNEST E. JUST, famous Negro biologist, spent many years at Woods Hole (*cf.* Science 95:10-11). The few biological stations located in the Southern United States do not admit Negroes. These stations feel they must follow the unjust mores of their region rather than lead in the *application* of scientific truth as they lead in the *investigation* of scientific truth.— (4) The student bodies of biological stations do not tend to be as international as the investigators at these institutions often are. The language barrier is one reason for this, since a person studying formally in a foreign country must be a better linguist than one doing research work. Another reason is that the course work at biological stations is generally duplicated at these institutions in many countries. There is not, therefore, the urgent need to cross national frontiers for course work as there is to do so in order to carry out investigations with rare forms or in unique environments. A third reason for the small proportion of foreign students at most biological stations, compared to the number of foreign investigators, is that most biologists have not attempted to excel as teachers. While an investigator might cross the ocean to work under the direction of a noted scientist, a person is less inclined to do so as a student, because there are fewer outstanding scientists with whom he may work at a biological station as a beginner. In certain instances, however, some foreign students may be found taking courses at biological stations. Systematic efforts should be made to facilitate the exchange of biological station students across international borders.

Research at Biological Stations: — Research is one of the primary functions of biological stations. Almost nine-tenths of these institutions offer research facilities. These are available to three types of persons: staff investigators, independent investigators, and student investigators. Several stations are prepared to accommodate all types, while others receive, for example, only independent investigators. Whatever the practices of the stations devoted to research, each type of investigator accommodated demands certain facilities from the station, while it in turn makes certain demands upon the investigator.

In addition to the living facilities and equipment offered to the different types of investigators, many biological stations attempt to furnish certain other opportunities to resident investigators and often also to research workers quite removed from the station. These include facilities for publication, supplies of biological specimens, and scientific symposia and conferences.

Research by Staff Investigators. — A portion of the research work done at almost nine-tenths of the biological stations is carried on by staff members of these institutions. The remaining stations either offer formal instruction exclusively, or are only prepared to offer facilities to visiting, independent investigators. The staff investigators who do pursue research problems are either permanent or part-time members, the latter often also giving formal instruction or supervising student research at the station.

Almost one-half of the biological stations maintain a permanent research staff. This practice varies with the customs of the countries in which these institutions are located. All of the Russian stations, for example, have a permanent staff, while none of the Algerian stations do. The larger countries with a high proportion of the field stations maintaining a permanent staff include Italy, Spain, Germany, and England. Those countries with a low proportion of stations with a permanent research staff have a complementary high proportion of stations with part-time staff investigators.

Permanent Staff and Program. — More than one hundred biological stations have a permanent, year-round staff. The actual number of staff members at these institutions varies from fifteen (*i.e.,* Scripps Institution

of Oceanography) to one (*e.g.,* Danish Arctic Station). The staff of more than one-half of these stations is composed of only one or two members. Only seventeen stations have five or more members of their permanent research staff. In addition, most of the larger stations have a number of full-time laboratory technicians, assistants, and administrative employees (especially librarians) who all aid in the research output of the institution.

The field stations which do have permanent staffs either do research on general biological problems or, due to sponsorship or location, concentrate their work in certain fields. Almost one-third of the stations specialize in research in marine biology. Other major fields of specialization at these institutions include fresh-water biology, fisheries, and oceanography.

Research institutions, especially in the more theoretical sciences, have often failed to bring about the coordination of personnel to the degree which some think to be necessary to make for the greatest efficiency in research. While this is often due to limited funds and equipment, it is perhaps equally due to lack of tradition for a type of teamwork in theoretical science that is comparable to that accomplished by the more practical scientific research institutions. At most biological stations with a permanent staff, the investigators — although staff members — work quite independently and their problems have little relation with each other. At a few biological stations, however, and especially at those dealing at least in part with applied biology, there is more of a closely correlated research program. There are evidences, too, that this coordination is slowly spreading to more biological station research programs.

The actual research programs of biological stations are too diverse for adequate generalization.[1] It may be said perhaps that these programs have attempted to keep abreast of the general trends in biological research, although some have lagged behind while others have pioneered for the science as a whole.

Part-time Staff and Program. — More than one hundred biological stations have a part-time staff of investigators. These persons are usually expected to do research during the period of the year that they are attached to the station or to do as much research as they are able after giving formal instruction or supervising student research at the station. The number of staff members of these institutions varies from twenty-two persons (*i.e.,* Marine Biological Laboratory) to one (*e.g.,* Royal Hydrobiological Station of Lake Trasimeno). Almost two-thirds of these stations have only one or two investigators, and the average part-time staff consists of three members. Twelve stations have five or more staff members, and ten of these are located in the United States. In addition to staff investigators, these institutions also employ part-time laboratory assistants and technicians to aid the investigators with the more routine laboratory and field tasks.

The biological stations with part-time investigators have less of a specialized research program than even those institutions with permanent staffs. The specialization of almost one-half of these biological stations with part-time staffs is due to its location either on fresh bodies of water or on the sea, while an additional one-third of these institutions pursue a research program in general biology. A few of these stations center their researches around such special fields as botany, ecology, or fisheries.

If the research program at those biological stations with a permanent staff is often uncoordinated, that at the institutions with a part-time staff is generally more so. Frequently the part-time investigator, although invited to undertake research work at the station, is also expected to supervise student research and give formal instruction. In such cases, whatever research the investigator does is secondary to any research program the station may have. The part-time staff member becomes, in reality, an independent investigator whose laboratory and often living fees are met by the station. The result is that the investigator spends his time completing previous research or inaugurating a project of his own interest which is often unrelated to that of his colleagues at the field station. A few of the institutions with part-time investigators do, however, have a well-correlated research program. This is due either to the part-time staff spending its full time in research or, less frequently, the retention of the same investigator year after year — a procedure not commonly adopted by most stations.

While stations in this category are characterized as institutions with a part-time staff, this does not necessarily mean that they are closed for a portion of the year. About one-quarter of these institutions are open throughout the year. Such stations may be open to staff investigators on a twelve-month basis, but the investigators are only hired on a part-time arrangement.

Research by Independent Investigators. — More than nine out of ten biological stations offer research facilities to independent investigators. Of the institutions which do not, a majority are biological nature camps which are concerned usually with elementary instruction. A few institutions do not admit visiting investigators because their limited budget can accommodate only members of their permanent staff (*e.g.*, Pacific Biological Station) or because the station is in the process of organization and has no facilities to offer visiting investigators (*e.g.*, Rocky Mountain Biological Station of the University of Michigan).

The biological stations which offer facilities to visiting investigators have various conditions for their admittance. Some institutions admit investigators in any biological subject quite unreservedly and with few formalities. Other stations carefully review the qualifications and proposed research program of the applicant and then he or she is admitted only if the research project coincides with the general aims of the station. In general, all stations at least want to know the problem the investigator will pursue and the time of his arrival, so they can better prepare for his investigations.

After the independent investigator is admitted to a biological station, he may or may not be assessed laboratory fees. More than one-half of the biological stations do not charge fees. About one-fifth of the institutions have laboratory fees which range from five to fifteen dollars a month, while another one-fifth charge monthly fees equivalent to more than fifteen dollars. The most expensive fee is one hundred dollars a month (*i.e.*, Mount Evans Laboratory).

A method whereby a field station obtains income from the facilities it offers, yet not from the individual investigator, is the so-called table system. This is believed to have been inaugurated by the Zoological Station of Naples. It has been adopted, with some alterations, by other institutions[2].

As the laboratory fees or table arrangements differ, so do the facilities which biological stations put at the disposal of the visiting investigators. Some of the smaller stations permit the investigators to use whatever equipment is available. Others attempt to give the research workers as much complicated apparatus and as many special solutions as the institution can afford. In addition, stations often supply the investigators with fresh animal and plant forms daily, if required. The facilities offered to investigators and the procedures by which they may be obtained are often codified in the form of laboratory rules.

In addition to laboratory facilities, visiting investigators are often given certain concessions by virtue of their connections with some biological stations. Occasionally they are privileged to bring scientific apparatus into the country in which the station is located duty free (*e.g.*, Zoological Station of Naples). Some stations obtain reduced transportation rates for research workers (*e.g.*, Bermuda Biological Station for Research, Inc.). Other stations which are not able to provide full living facilities to investigators also may obtain reductions in living costs at nearby hotels or restaurants for them (*e.g.*, Jungfraujoch Scientific Station).

In furnishing laboratory facilities to independent investigators, biological stations do so with the implied agreement that the worker will do his best to contribute to the progress of science. Most stations ask no more of the investigator. Some of these institutions, however, expect that the investigator will partially repay the station in one of several tangible ways. These include identifying animal and plant forms, acknowledging indebtedness to the station in printed reports of any work done at the station, compiling a separate report of research undertaken, and donating reprints of any published research to the station library.

The number of investigators who take advantage of the facilities offered by biological stations varies with the time of the year and — over longer periods of time — with economic and international conditions. About three-quarters of the stations which offer facilities to investigators of this type are open throughout the year. As only a few independent investigators are on year-round fellowships or sabbatical leaves of absence, the summer months or short periods at Easter recess are the only time that the majority of research workers are able to make use of these facilities. As a rule, therefore, many of these stations are crowded in the summer months and — if open at all — are quite empty in winter.

The maximum number of investigators which these institutions can accommodate at any one time varies from two (*e.g.*, Marine Laboratory of the University of Sydney) to more than 250 (*i.e.*, Marine Biological Laboratory). More than two-thirds of these institutions accommodate no more than ten visiting investigators. Those stations which have facilities for more than twenty-five independent investigators include the institutions at Bermuda, Salisbury Cove (Maine), Plymouth, Villefranche, Helgoland, Naples, and Woods Hole (Marine Biological Laboratory).

The actual research work done by the independent investigator at biological stations is often in the field. There are instances, however, where the investigations are carried on exclusively in the laboratory, often with such forms as rabbits and mice. The investigations may be in a phase of theoretical biology or in one of the applied or border-line fields. Some are

life-time problems and others are projects which may be completed in a few weeks.

Research by Advanced Students. — Almost one-half of the biological stations are known to be equipped to receive advanced students who desire to do research work under direction. These institutions are, for the most part, stations which offer formal instruction, although in some instances stations devoted exclusively to research provide for the training of research investigators (*e.g.*, Woods Hole Oceanographic Institution). The supervisors of student research are usually faculty members also offering more formal class-work, although they may be permanent or part-time staff investigators who are qualified to direct research by their academic affiliation or attainment.

The conditions under which students are admitted to do research under direction vary considerably. A few stations allow undergraduate students to undertake research (*e.g.*, the Bowdoin Scientific Station is organized primarily for this purpose). Most field stations, however, offer such facilities only to graduate students who are working for a higher degree. Admission requirements in such cases usually coincide with those of the institutions which grant the degree.

Since the research work done at biological stations is often under the official direction of the institution which awards the advanced degree, the fees for such supervision of student research are controlled usually by the university concerned. These do not, however, differ greatly from those charged students taking formal course work. A number of student investigators are subsidized in their studies by fellowships and scholarships granted by the universities to which they are attached. In addition, several biological stations offer special fellowships to advanced student investigators.

The actual research done under supervision at biological stations includes field and laboratory work in many branches of biology. Many of the problems are of a relatively limited scope, often being connected with the larger work or interest of the supervising faculty member. Some of this research is written up as theses in partial fulfillment for advanced university degrees. In other instances, the studies are preliminary.

Facilities for Publication. — Biological stations occasionally offer staff and independent investigators opportunities for the publication of the results of their researches. These facilities are in the form of serial publications issued by the field station. A few of these serials are published bi-monthly (*e.g., Biological Bulletin* of the Marine Biological Laboratory), while others are issued annually (*e.g., Bulletin of the Mount Desert Island Biological Laboratory*). A number are issued only occasionally (*e.g., Fauna et Flora Laurentianae* of the St. Lawrence Biological Station).

The material in these publications of biological stations is generally limited to reports of research undertaken at the station (*e.g., Palao Tropical Biological Studies*), although sometimes they include papers reporting investigations conducted elsewhere (*e.g., Der Vogelzug* of the Rossitten Bird Observatory). While most of the material in these serials is the result of scientific work, space is devoted in some of these publications to reports of the general work and financial condition of these institutions (*e.g., Annual*

Report of the Freshwater Biological Association of the British Empire). The larger stations are able to separate the types of articles included in these publications by issuing several kinds of serials (*e.g., Thalassia* and *Note* of the Italian-German Institute of Marine Biology).

The oldest serial publication issued by any biological station is believed to be the *Fauna et Flora del Golfo di Napoli*. This was first published by the Zoological Station of Naples in 1880. The most recent serial bulletin to be established by a biological station is the *Publication of the Marine Biological Station, Ghardaqa* (1939). Several well-known publications of biological stations have been compelled, for one or more reasons, to discontinue or at least merge with other journals. These include *Mittheilungen aus der Zoologischen Station zu Neapel* (which became *Pubblicazioni della Stazione Zoologica* after its twenty-second volume), *Travaux du Laboratoire de Zoologie et Physiologie maritime à Concarneau* (which was discontinued during the first World War), and *Wissenschaftliche Meeresuntersuchungen, Abth. Helgoland* (which since June 1937 has been *Helgoländer Wissenschaftliche Meeresuntersuchungen*).

In addition to providing publication facilities to research investigators, biological stations are able to use these serials to obtain similar journals from other scientific institutions by means of exchanges. Those stations which do not publish serials occasionally issue a limited edition of collected reprints of published research work done at the station (*e.g., Collected Reprints* of the Woods Hole Oceanographic Institution). These, too, are frequently used for exchange purposes.

The research papers of investigators at the biological stations which do not publish scientific serials usually appear in the appropriate journals of other scientific institutions or organizations. In some instances, certain journals quite independent of the biological station often receive most of the research papers originating from that station. Thus many articles describing the results of research undertaken at the Zoological Station of Algiers appear in *Bulletin de la Société d'Histoire Naturelle Afrique du Nord*. Often an institution sponsoring a biological station publishes the research work of that station in its scientific publications. Thus many of the researches completed at the Allegany School of Natural History have appeared in the various publications of the New York State Museum which, for some years, was a co-sponsor of that station.

The Supply of Biological Specimens.—A method by which biological stations contribute to research and instruction is the collection and sale of preserved and living biological specimens. Some biological stations were organized because biologists for their research and instructional needs were unable to obtain necessary biological forms. Laboratories were therefore set up where these could be more easily obtained. Now some of these very same laboratories are making it possible for biologists to receive living and preserved specimens many hundreds of miles away from the natural environment of these forms.

At least twelve biological stations have well-organized biological supply departments. These include the stations located at Amoy, Plymouth, Wray Castle, Helgoland, Krefeld, Ennur, Naples, Rovigno, Helder, Portobello, Millport, and Woods Hole (Marine Biological Laboratory). Some of these

departments do a relatively small annual business, although that of the Marine Biological Laboratory had a gross income of almost $40,000 in 1938. Most of these supply departments issue some kind of price-list for prospective individual and institutional purchasers.

The disadvantage of this auxiliary service of a biological station is that many of the materials must be collected in the immediate neighborhood of the laboratory. The type of wholesale collecting which it is necessary for most supply departments to do often negates the advantages, both financial and scientific, of operating this service.

Scientific Lectures and Conferences. — A method used by a few of the larger biological stations to promote the advancement of science in general is the sponsoring of scientific lectures and conferences. Some stations schedule a series of scientific lectures to be delivered at the station by staff members, visiting investigators, or special lecturers. These talks are sometimes about subjects of general biological interest, while at other times they are on very specialized topics. In both cases, they result in a broadening of the knowledge and interests of those research investigators attending them. Often information on the results of unpublished scientific experiments and observations are divulged for the first time at these talks.

Biological stations are occasionally hosts to various biological symposia, conventions, and congresses. The Symposia on Quantitative Biology of the Biological Laboratory of the Long Island Biological Association are perhaps the most noted of such conferences to be sponsored by field stations in recent years. While this symposium has been inaugurated by the station and is an annual event, others are organized by independent scientific organizations and convene at the biological station for only a single occasion. When the Fourth Pacific Science Congress met in Java in 1929, the Visitors' Laboratory at Buitenzorg was host to many visiting botanists. In North America, the Genetics Society has held summer meetings at the Marine Biological Laboratory for several years. Such conferences at biological stations often introduce students and investigators to the visiting scientists and they, in turn, are introduced to the work and potentialities of the station.

Notes: — (1) A splendid account of the research program for the first twenty years at one station is given by Frank R. Lillie: The Woods Hole Marine Biological Laboratory. University of Chicago Press, pp. 115-56, 1944. — (2) These table systems have helped to make possible the international exchange of investigators at biological stations. Few systematic attempts have been made in peacetime to overcome the normal difficulties of foreign research and thus facilitate the interchange of investigators.

* * * * *

The following directory brings together information on 271 biological stations in fifty-nine political areas. The description of each station has been necessarily limited to fit within the format of this study. An attempt is made, however, to give at least the following enduring facts about each station: the location, the name, the sponsoring organization, the purpose, the unique equipment, and the name of its scientific publications. Less often information is given on the biological surroundings of the station, the date of foundation, and the time of year the station usually has been open (if

normally closed for a portion of the year). Occasionally less permanent but often indicative information is given, such as the annual budget, the name of the director, the number of resident scientific investigators, the type and size of boats, and a description of the course work offered. No attempt is made to give the most recent information available on the names of staff members, the number of menial employees, the size of the library, the cost of board and lodging, the maximum number of students accommodated, tuition costs, and the fees assessed independent investigators.

An attempt is also made to give for most stations a fairly complete listing of existing bibliographic references to descriptions of them and their facilities. Space has not been sufficient to give the titles, authors, and dates of these articles, but for convenience the references are listed in chronological order (the first given being the oldest). Perhaps the most consistently useful descriptions of many of these institutions are found in the previous, older catalogues of biological stations. These have been abbreviated in this directory as follows:

Chronica Botanica....Chronica Botanica Co. Leyden, Zuid-Holland and Waltham, Massachusetts. Vol. I (1935) *seq.*

Dean 1894....Dean, Bashford. Notes on marine laboratories of Europe. Report of the Smithsonian Institution for 1893:505-19, 1894.

Juday 1910....Juday, Chancey. Some European biological stations. Transactions of the Wisconsin Academy of Sciences, Arts, and Letters 16:1257-77, 1910.

Kofoid 1910....Kofoid, Charles Atwood. The biological stations of Europe. United States Bureau of Education Bulletin 1910(4):1-360, 55 pls., 48 figs. 1910.

Lenz 1927....Lenz, F. Limnologische Laboratorien. Handbuch der Biologischen Arbeitsmethoden 9, *2*(1):1285-1368, 1927.

Magrini 1927....Magrini, G. Instituts et laboratoires s'occupant de l'étude de la mer. Conseil International de Recherches, Union Géodésique et Géophysique Internationale, Section d'Océanographie, Bulletin 7:1-115, 1927.

Ricker 1937....Ricker, W. E. Glimpses at fishery biology and fish culture in Europe. Progressive Fish Culturist 31:29-33; *Ibid.* 32:12-15; *Ibid.* 34:12-14, 1937.

Sand 1898....Sand, René. Les laboratoires maritimes de zoologie. Revue de l'Université de Bruxelles 3:23-47, 121-51, 203-35, 1898.

Scourfield 1905....Scourfield, D. J. Fresh-water biological stations. Jour. Quekett Micro. Club II, 9(56):129-36, 1905.

Turtox....General Biological Supply House. Biological field work. 1928-32, 1934, 1935, 1937. Chicago, Illinois.

Vaughan 1934....Vaughan, T. W. Catalogue of marine stations of the Pacific. International Commission on the Oceanography of the Pacific, Report of the Chairman. Fifth Pacific Science Congress Proceedings 1:361-80, 1934.

Vaughan 1937....Vaughan, T. W. Catalogue of institutions engaged in oceanographic work. In International aspects of oceanography. (T. W. Vaughan and others.) 225 pp. Washington: National Academy of Sciences. 1937, pp. 73-225.

DIRECTORY *of* BIOLOGICAL STATIONS

It must be re-emphasized that, with few exceptions, the descriptive accounts given here are corrected to 1940—before World War II became world-wide. As the war progressed, many of these institutions curtailed their activity and some even suspended operation. Despite these changes wrought by the war, it has been thought useful for biologists and others to have a picture of these institutions at perhaps the peak of their operation (1939-40)*.

—*ALASKA*—

Little Port Walter (Baranof Island): **Field Laboratory of the United States Fish and Wildlife Service:** — About 18 miles from the open ocean, with one stream flowing into the bay and that originating in a series of mountain lakes. Established in 1941 by the U.S. Fish and Wildlife Service for the study of the natural reproduction of pink salmon. Laboratory and living facilities are available for visiting biologists. — *Cf.* Science 94:295.

—*ALGERIA*—

Algiers: **Station Zoologique d'Alger:** — Founded in 1888, this institution is conducted by the Faculty of Sciences of the University of Algiers. There is a two-story laboratory building. — *Cf.* La Nature 16(2):327-30; SAND 1898; VAUGHAN 1937.

Beni Ounif: **Laboratoire de Biologie Saharienne:** — Situated in a stony desert near a date palm oasis and ten miles from the mountains of Morocco. Founded in 1930 and attached to the Faculty of Sciences of the University of Algiers. The building contains four laboratories and a herbarium. — *Cf.* Chronica Botanica 1938.

Maison-Carrée: **Station Botanique de Maison-Carrée.**

—*ARGENTINA*—

Quenquén: **Estacion de Biología Marina del Museo Argentino de Ciencias Naturales de Buenos Aires.**

—*AUSTRALIA*—

Cronulla (New South Wales): **Commonwealth Fishery Research Laboratories:** — Sponsored by the Council for Scientific and Industrial Research of the Commonwealth of Australia. There are two large, well-equipped laboratory buildings. Two-ton truck available as a mobile laboratory for coastal work. Several large boats available, including 82-foot, 138-ton M. V. Warreen. — *Cf.* Nature 144:312-13; VAUGHAN 1937.

Narrabeen (New South Wales): **Biological Field Station of the Sydney University Biological Society:** — Founded in 1934 and sponsored by the Sydney University Biological Society. In a suburb of Sydney, where there are laboratory and living accommodations. — *Cf.* Nature 134:602, 623; Chronica Botanica 1:81; *Ibid.* 2:73.

Port Jackson (New South Wales): **Marine Laboratory of the University of Sydney:** — Situated in Sydney harbor and equipped for research and instruction in marine biology and oceanography. Sponsored by the Department of Zoology of the

---

* Beyond the scope of this directory are accounts of the numerous biological stations of the past (*cf. supra*, p. 10-11). — Dr. VERDOORN has expressed his willingness to publish a historical account of these stations. Much material concerning them may be found in my manuscript thesis (*cf. supra*, p. 5). In the CHRONICA BOTANICA ARCHIVES there is a file of several thousand cards dealing with the history of botanical gardens, museums, etc. This includes quite some data concerning early biological stations (*cf.* CHRONICA BOTANICA 8:445).

University of Sydney with funds contributed also by the Australian Research Council and the Commonwealth Council for Scientific and Industrial Research. 13-ton auxiliary yacht with oceanographical apparatus available. — *Cf.* Science 74:202; VAUGHAN 1934; VAUGHAN 1937.

— BELGIUM —

Ostend: **Institut Maritime de Belgique:** — Founded in 1900, reorganized in 1935 and now connected with the Royal Museum of Natural History of Brussels. — Research published in Annales de l'Institut Maritime de Belgique. — *Cf.* VAUGHAN 1937.

Rouge-Cloître (Brabant): **Laboratoire de Biologie Lacustre.**

Sourbrodt: **Station Scientifique des Fagnes:** — Located in the bogs of the Belgian Ardennes at an altitude of 2,211 feet. Founded in 1928 by the University of Liège and under the supervision of Professor RAY. BOUILLENNE. The station is open normally from June to October and both laboratory and living accommodations are available. — *Cf.* Bull. Soc. Roy. Bot. Belg. 58:20-24; Chronica Botanica 1:93; *Ibid.* 2:85.

— BERMUDA —

St. George's: **Bermuda Biological Station for Research, Inc.:** — Founded in 1903 at Flatts, Bermuda and moved to present location in 1932. Sponsored to offer facilities for research in biology and oceanography in the Bermuda region by an international board of trustees on which are representatives from Bermuda, England, Canada, and the United States. The 12-acre plant includes complete laboratory and living facilities. Oceanographic research vessel, Culver, attached to the station, as is a 24-foot launch. Investigators may obtain reduced steamship rates and exemption from paying customs on their scientific supplies and equipment. — *Station publications:* report of the officers; contributions, Bermuda Biological Station for Research, Inc. (1931-); and Collected Reprints, Bermuda Biological Station for Research, Inc. — *Cf.* Chambers Jour. 6(7):783-84; Pop. Sc. 66:393-411, 556-72; Science 65:128-30; *Ibid.* 73:488-89; *Ibid.* 75:133-36; Nature 139:948-51; Science 89:28; *Ibid.* 94:319; Chronica Botanica 1935; *Ibid.* 1936; *Ibid.* 1938; Turtox 1937; VAUGHAN 1937.

— BRAZIL —

Alto da Serra: **Estação Biológica do Depto. de Botánica do Estado:** — Near São Paulo at an altitude of 2,400 feet in a virgin sanctuary for native animals and plants. Founded in 1909 and now supervised by Professor F. C. HOEHNE. — *Cf.* Ber. Deutsch. Bot. Ges. 50:154-64; Scientific Monthly 25:5-8; Chronica Botanica 1935; *Ibid.* 1936.

Itatiaia (Rio de Janeiro): **National Park and Biological Laboratory.**

— BULGARIA —

Varna: **Biological Station and Aquarium:** — Situated on the Black Sea near a rocky and sandy shallow-water zone which is rich in animal and plant life and thus equipped for research and instruction in marine biology. Begun in 1906 but not opened until 1932 and now sponsored by the University of Sofia. There is a 3-story laboratory building which contains a public aquarium, research laboratories, dormitories, and a library. Courses are offered in hydrobiology and natural history for teachers. — *Station publication:* Arbeiten aus der Biologischen Meeres-station am Schwarzen Meer. — *Cf.* Int. Rev. Hydrobiol. 1:745-46; *Ibid.* 29:157-58; JUDAY 1910; KOFOID 1910.

— CANADA —

Algonquin Park (Ontario): **Ontario Fisheries Research Laboratory:** — Sponsored by the University of Toronto for research of fisheries resources. Founded in 1919-20, the laboratory was moved to present site in 1936 and now is under the direction of Professor WILLIAM J. K. HARKNESS. Laboratory and living accommodations are available. — *Station publication:* University of Toronto Studies, Biological Series. Publications of the Ontario Fisheries Research Laboratory (1922-).

Kent Island (New Brunswick): **Bowdoin Scientific Station:** — Founded in 1935 by WILLIAM A. O. GROSS of Bowdoin College (U.S.A.) to inspire research in biology and meteorology by undergraduates. Six, well-equipped buildings are available for

research from June fifteenth to September fifteenth. — *Station publications:* Contributions from the Bowdoin Scientific Station (1938-   ); and annual report (mimeographed). — *Cf.* Natural History 37:195-210.

Nanaimo (British Columbia): **Pacific Biological Station:** — Sponsored by the Fisheries Research Board of Canada for scientific investigation of marine and fresh-water problems. Dr. W. A. Clemens directs the large plant, which includes many well-equipped laboratories, museum, library, dormitory, kitchen, and staff offices. A 60-foot boat is available for oceanographical investigations. — *Cf.* Proceedings and Transactions of the Royal Society of Canada 3(2):lxxiii-lxxiv; Fifth Pacific Science Congress 1:200; Magrini 1927; Turtox 1937; Vaughan 1934; Vaughan 1937.

St. Andrews (New Brunswick): **Atlantic Biological Station:** — Sponsored by the Fisheries Research Board of Canada to provide facilities for research on fresh and salt-water fisheries. It is on the shore of a deep, tidal estuary of the St. Croix River. There are several laboratory buildings, experimental aquarium tanks and pools, a 90-foot diesel-engine research vessel, Zoarces, and a 28-foot vessel, Delphine. — *Cf.* Proceedings and Transactions of the Royal Society of Canada 2(4):xiii; *Ibid.* 2(5):xxi-xxii; *Ibid.* 2(6)xiii-xv; Magrini 1927; Turtox 1937; Vaughan 1937. Bot. Gaz. 27:79.

Trois-Pistoles (Province of Quebec): **Station Biologique du St.-Laurent:** — Located on the south shore of an estuary of the St. Lawrence River for the purpose of studying the hydrography, flora, and fauna of the region. Founded in 1931 by Laval University and now sponsored by this institution. Professor Alexandre Vachon directs the work of this station which consists of a 2-story laboratory building and the 50-foot boat, Laval. — *Station publications:* Rapports annuels (1932-   ); Contributions de la Station Biologique du Saint Laurent (1932-   ); Fauna et Flora Laurentianae (1936-   ). — *Cf.* Vaughan 1937.

— *CAROLINE ISLANDS* —

Korror Island: **Palao Tropical Biological Station:** — Sponsored by the Japanese Society for the Promotion of Scientific Research for research in the biology of coral reefs. Professor S. Hatai is the director of the station which is housed in a one-story building. — *Station publication:* The Palao Tropical Biological Studies. — *Cf.* Nature 140:735; Vaughan 1937.

— *CEYLON* —

Colombo: **Fisheries Research Station.**
Peradeniya: **Visitors' Lab. of the R. Botanic Garden.**

— *CHILE* —

Corral: **Estación de Oceanografía.**

— *CHINA* —

Amoy (Fukien Province): **Amoy Marine Biological Station:** — (This station has moved inland to Tingchow for the duration.) Founded in 1934 to promote the study of marine biology by the University of Amoy. Professor T. Y. Chen is director of the station which offers a course in marine biology during the summer months. — *Station publications:* Amoy Marine Biological Bulletin; Annual Report of the Amoy Marine Biological Station (in Chinese). — *Cf.* Science 72:429-30; Vaughan 1934; Vaughan 1937.

Sen-Kia-Men (Chusan Islands, Chekiang); **Tinghai Marine Station:** — Founded in 1936 for biological and oceanographic research and later sponsored by the National Research Institute of Biology. — *Cf.* Vaughan 1934; Vaughan 1937.

Tsingtao (Shantung): **Tsingtao Marine Biological Station:** — Sponsored by the Academia Sinica and several other societies. The building was started and almost completed in July 1937, when the war started.

— *CUBA* —

Habana: **Institute for Marine Biology:** — The establishment of a new institute of marine biology has recently been authorized by the Dept. of Agriculture of the Govt. of Cuba. It is being located at Castillo de la Punta. The institute will include a library, a museum, a div. of "industrial experimentation", etc.

Soledad: **Atkins Institution of the Arnold Arboretum:** — Founded in 1898 by EDWIN F. ATKINS and now sponsored by Harvard University for tropical research in botany and zoology. Professor THOMAS BARBOUR directs the work of the station which is housed in one well-equipped laboratory building. There are separate living quarters and a 200-acre botanical garden devoted to the cultivation of economic plants. There are accommodations for six investigators at one time. — *Cf.* Science 59:433-34; Jour. of Heredity 15:451-61; Bul. Pan-American Union 70:631-38; Sci. Mon. 51:140-46; Science 94:534.

— *CZECHOSLOVAKIA** —

Blatná: **Station für Hydrobiologie und Fischzucht an den Lnáreteichen:** — Cf. LENZ 1927; Chronica Botanica 1936.

Hirschberg [*Doksy*] (Böhmen): **Station Hirschberg a. See der Reichsanstalt für Fischerei:** — Founded in 1905 by Dr. VIKTOR LANGHANS for hydrobiological research. Dr. TRUDE SCHREITER directs the work of the station which is housed in a 3-story building. — *Cf.* Verein der Naturfreunde in Reichenberg 60:46-49; KOFOID 1910; LENZ 1927.

Krtiny (Moravia): **Biologická Stanice Céskych Vysokychškol Brněnských:**—Sponsored by the Czechoslovakian Academy of Sciences and the Ministry of Education for research in general biology in a region of hilly lands and ponds. — *Cf.* LENZ 1927; Chronica Botanica 1935.

Samorin (near Bratislava): **Biologická Stanice Komenského University:** — Cf. Chronica Botanica 1936.

Strbské Pleso (Vysoké Tatry): **Geobotanical Station of the Czechoslovakian Botanical Society:** — Founded in 1931 and now sponsored by the Czechoslovakian Botanical Society for research in botany, ecology, and phyto-sociology. Station open to investigators from May first to November first.

Velké Meziříčí (Mähren): **Die Franz Harrach'sche Station für Fischerei und Hydrobiologie:** — Founded in 1928 by FRANZ HARRACH and now an independent institution. There is one, well-equipped building.

— *DENMARK* —

Charlottenlund Slot (Copenhagen): **Dansk Biologisk Station:** — Situated on the narrow sound separating Denmark from Sweden south of the Kattegat, with a freshwater annex at Frederiksdal. Sponsored by the Danish Ministry of Agriculture and Fisheries for investigations on marine and fresh-water problems. Dr. H. BLEGVAD directs the work of the station, which has a budget of 140,000 Kroner. Laboratory headquarters are in Charlottenlund Castle. 143-ton research steamer, Biologen, available for research problems between April first and October twentieth. — *Station publication:* Report of the Danish Biological Station (1890-91-). — *Cf.* Revue Générale des Sciences 47:623-30; SAND 1898; KOFOID 1910; MAGRINI 1927; VAUGHAN 1937; RICKER 1937.

Frederikshavn: **Universitetets Havbiologiske Laboratorium.**

Hillerød: **Universitetets Ferskvandsbiologiske Laboratorium:** — Situated on the shore of shallow Frederiksberg Castle Lake for the purpose of research and instruction in freshwater biology. Sponsored by the University of Copenhagen under the direction of Professor KAJ BERG. There is a 2-story, well-equipped laboratory building. A 3-week course is offered in summer to university students in fresh-water biology. — *Cf.* Int. Rev. Hydrobiol. 3:128-35; Arch. für Hydrobiol. 32(4):1-6; SCOURFIELD 1905; KOFOID 1910; JUDAY 1910; LENZ 1927; RICKER 1937.

Noudby (Skalling Peninsula): **Skalling-Laboratoriet:** — Sponsored by the Carlsberg Foundation for investigations of marshes, dunes, and sandflats. Two field laboratories are available to investigators, one in Noudby Harbor and another on Skalling Peninsula. — *Station publication:* Meddelelser fra Skalling-Laboratoriet (1935-).

* Territorial boundaries as of August 1938.

—EGYPT—

Alexandria: **Fouad I Institute of Hydrobiology and Fisheries:**— Founded in 1931 and now sponsored by the Egyptian Ministry of Commerce and Industry for research on the marine and fresh-water fishes of Egypt. Dr. HUSSEIN FAOUZI is the director of a staff of five research assistants. The 3-story laboratory building contains a public aquarium, offices, library, museum, and many well-equipped laboratories. Services of the government, 42-meter Mabahiss, are available.—*Station publication:* Notes and Memoirs of the Fouad I Institute of Hydrobiology and Fisheries (1933-).—*Cf.* Int. Rev. Hydrobiol. 30:383; Nature 141:1107; VAUGHAN 1937.

Ghardaqa: **Marine Biological Station of the Fouad I University:**— Founded in 1930 by Dr. CYRIL CROSSLAND for the Faculty of Science of the Fouad I University. On the Red Sea, at the most northernly extension of the Indo-Pacific fauna. Every variety of coral reef is to be found within easy reach of the station. There are several well-equipped laboratory and living buildings. Boats are available. The station is open throughout the year, although optimum climatic and collecting conditions are during the summer months.—*Station publications:* Announcement; Publications of the Marine Biological Station, Ghardaqa (1939-).—*Cf.* Nature 126: 991-93; *Ibid.* 134:743-44; Chronica Botanica 1935; VAUGHAN 1937.

Heliopolis (Cairo): **Institute of Desert Researches.**

—EIRE—

Lough Ine (Skibbereen, County Cork): **Cork University Biological Station:**— On a tidal marine lough communicating with the sea by a very narrow-stepped channel. Founded in 1925 by Professor LOUIS P. W. RENOUF and now sponsored by University College, Cork, for the purpose of working out the ecology of the immediate neighborhood and providing research facilities to visiting biologists. Courses offered in marine biology and ecology.—*Cf.* Journal of Ecology 19(2):410-38.

—ENGLAND—

Ambleside (Westmoreland): **Laboratory of the Freshwater Biological Association of the British Empire:**— Founded in 1929 to promote the investigation of the biology of the animals and plants found in fresh (and brackish) waters. Sponsored by the Freshwater Biological Association of the British Empire with a budget of £4,084. Dr. E. B. WORTHINGTON is director of a staff of seven resident investigators. The station is housed in Wray Castle and is equipped with modern laboratory and living facilities. A course is offered in the principles of freshwater biology.—*Station publications:* Annual Report of the Freshwater Biological Association of the British Empire; Scientific Publication (1939-).—*Cf.* Science 72:554; Nature 125:241-42; Science 76:248; Nature 130:140; Int. Rev. Hydrobiol. 30:247-50; Nature 142:238; Chronica Botanica 1938 and 1939.

Blakeney Point (Norfolk): **Blakeney Point Research Station:**— Situated on a peninsula on the Norfolk coast, with sand dunes, salt marshes, and mud flats easily accessible. Founded in 1913 for research in the ecology and ornithology of the region.—*Station publications:* Blakeney Point Publications (1912-); Occasional Reports of the Blakeney Point Research Station (usually appearing in the Transactions of the Norfolk and Norwich Naturalists' Society).

Cullercoats (Northumberland): **Dove Marine Laboratory:**— Founded in 1897 by Prof. ALEXANDER MEEK and now sponsored by Armstrong College of the University of Durham, with A. D. HOBSON as director. The 2-story laboratory building contains rooms for the classes held each Easter holiday.—*Station publication:* Dove Marine Laboratory Report.—*Cf.* JUDAY 1910; KOFOID 1910; MAGRINI 1927; VAUGHAN 1937.

Plymouth: **Plymouth Laboratory of the Marine Biological Association of the United Kingdom:**— The Devon and Cornwall shore line supports an extensive and varied fauna which is exposed by the considerable rise and fall of the tide. The station was established in 1884, opened in 1888, with additions erected in 1920, 1922, 1926, and 1939. It is sponsored by the Marine Biological Association of the United Kingdom on a budget of £16,000 annually. Dr. STANLEY KEMP is director and there are twelve resident members of the staff. The plant consists of three, well-equipped laboratory buildings which contain a public aquarium, a 20,000-volume library, biological supply

sales department, classrooms, and research laboratories. The 88-foot steamer, Salpa, is equipped for trawling and plankton work and the 25-foot motorboat, Gammarus, is also available. Courses in marine biology are offered during the Easter and autumn vacations. Laboratory accommodations are available for thirty investigators in addition to the resident staff.—*Station publications:* Journal of the Marine Biological Association of the United Kingdom (1889-); Report of the Council; Syllabus of the Course in Marine Biology; Guide to the Plymouth Aquarium.—*Cf.* The Times, London, March 31, 1884; *Ibid.* April 1, 1884; Nature 30:40, 82, 323, 350-51; Jour. Marine Biol. Assoc. 1:96-104; Nature 38:16-17; *Ibid.* 38:198-200; *Ibid.* 38:236-37; Jour. Marine Biol. Assoc. 15:734-828; New Statesman 28:105-06; Science 76:586; *Ibid.* 93:445; DEAN 1894; SAND 1898; JUDAY 1910; KOFOID 1910; MAGRINI 1927; Chronica Botanica 1935; *Ibid.* 1936; VAUGHAN 1937.

Port Erin (Isle of Man): **Marine Biological Station at Port Erin:**—On the Isle of Man in the middle of the Irish Sea and organized to provide research and instructional facilities in marine biology. Sponsored by the Department of Oceanography of the University of Liverpool with Prof. J. H. ORTON as director. There is a well-equipped, 2-story laboratory building and one 20-foot motorboat. Courses are given by professors of public schools and universities who come to the station with their classes for 2-week sessions, usually during the Easter recess.—*Station publications:* Report of the Marine Biological Station at Port Erin (1888-); Memoirs on Typical British Marine Plants and Animals of the Liverpool Marine Biological Committee (1899-); Proceedings and Transactions of the Liverpool Biological Society (1886-); General Regulations for Students.—*Cf.* Int. Rev. Hydrobiol. 1:740-45; Nature 82:321-22; Proc. Trans. Liverpool Biol. Soc. 34:23-74; Nature 146:58; Science 95:473; DEAN 1894; SAND 1898; JUDAY 1910; KOFOID 1910; MAGRINI 1927; Chronica Botanica 1936; VAUGHAN 1937.

Potterne (Wilts.): **Potterne Biological Station:**—*Cf.* Chronica Botanica 1:178; *Ibid.* 2:190.

Southampton: **Southampton Fisheries Station:**—On the River Itchen within easy access to a large variety of water conditions. Founded in 1932 as the Avon Biological Research Station by University College, Southampton, and now sponsored also by the Freshwater Biological Association of the British Empire.—*Station publication:* Annual Report of the Avon Biological Survey (1932-).—*Cf.* Chronica Botanica 1939.

—*ESTONIA*—

Tartu: **Kuusnõmme Bioloogia Jaam.**

—*FINLAND*—

Tvärminne: **Station Zoologique de Tvärminne:**—Readily accessible to the station is open sea (the Gulf of Finland) and also a long, fiord-like bay. Founded in 1902 and now sponsored by the University of Helsingfors with Prof. ALEXANDER LUTHER as director. There is a 2-story building which is open to independent investigators from May fifteenth to September tenth. 3-week courses are given in aquatic zoology, hydrology, and plant physiology.—*Cf.* LENZ 1927; Jahresb. Westpr. Bot.-Zool. Ver. 47:67-68.

—*FRANCE*—

Aix-les-Bains (Savoie): **Station d'Etudes Hydrobiologiques du Lac du Bourget:**—In a region of many large and small lakes, two large rivers, and easily accessible to the lakes of higher altitude in the Savoian and Dauphin Alps. Sponsored by the National School of Waters and Forests at Nancy to facilitate biological researches on the fresh-water lakes in France. The 2-story building contains a public aquarium, library, research laboratories, and living rooms. Open from April to October to qualified investigators.—*Cf.* La Nature, Paris 65(1):401-03.

Ambleteuse (Pas-de-Calais): **Station Biologique de l'Université Catholique de Lille (Laboratoire Charles Maurice):**—Established in 1895 by Prof. CHARLES MAURICE and now sponsored by the Catholic University of Lille. There is a laboratory building and also a chalet used for living accommodations.—*Cf.* KOFOID 1910; MAGRINI 1927.

Arcachon (Gironde): **Station Biologique d'Arcachon:**—Initiated in 1863 and sponsored by La Société scientifique d'Arcachon, with Prof. H. SIGALAS as director. The

two buildings contain a public aquarium, museum, well-equipped research laboratories, and living accommodations. A 31-foot motorboat is available. — *Station publications:* Bulletin de la Station Biologique d'Arcachon (1895-); Règlement des Laboratoires. —*Cf.* DEAN 1894; SAND 1898; KOFOID 1910; MAGRINI 1927; VAUGHAN 1937.

Bagnères-de-Bigorre (Hautes Pyrénées): **L'Institut et Observatoire de Physique du Globe du Pic-du-Midi:** — On the summit (9,437 feet) of a mountain in the Pyrenees. Sponsored by the University of Toulouse to aid scientists in making available to them laboratory and living facilities for research in physics and biology in high altitudes. The two weather-proof buildings contain well-equipped laboratories, library, and living quarters.

Banyuls-sur-Mer (Pyrénées Orientales): **Laboratoire Arago de Banyuls-sur-Mer:** — Sponsored by the Faculty of Sciences of the University of Paris for research and instruction in marine biology. Prof. E. CHATTON is director and there is a resident scientific staff of three persons. The plant contains a public aquarium, museum, library, classrooms, living accommodations, and well-equipped laboratories. A two-week course in marine biology is given usually during the Easter vacation and again in September. — *Cf.* Revue Scientifique 3(1):577-79; Arch. Zool. 1(9):563-98; Revue Scientifique 35:371-74; La Nature, Paris 14:97-99; Revue Scientifique 47:673-80; Revue des deux Mondes 120:168-86; Arch. Zool. 3(3):1-42; *Ibid.* 3(6):1-35; *Ibid.* 3(9):1-42; Cosmos 55:367-70; Revue Scientifique 70:750-53; DEAN 1894; SAND 1898; JUDAY 1910; KOFOID 1910; MAGRINI 1927; VAUGHAN 1937.

Besse (Puy-de-Dôme): **La Station Biologique de Besse:** — At an altitude of 3,444 feet, in a region of more than 20 lakes of glacial and volcanic origin. Sponsored by the Faculty of Sciences of the University of Clermont for the purpose of studying the flora and fauna of the mountains, especially the limnology of the waters. The laboratory building contains living facilities and also classrooms for the two-week course given for university students in biology. — *Station publication:* Arvernia Biologica (including Annales de la Station Limnologique de Besse). — *Cf.* Revue Inter. de l'Enseignement 39:128-31; Ann. Biol. Lacustre 1:1-32; Revue générale Scientifique 37:613-14; La Nature, Paris 64(2):358-60; KOFOID 1910; LENZ 1927; Chronica Botanica 1939.

Cévennes: **Laboratoire de Montagne de l'Aigoual (Université de Montpellier):** — According to Dr. and Mrs. VERDOORN, who visited this in 1932, without laboratory facilities.

Concarneau (Finistère, Brittany): **Laboratoire de Zoologie et de Physiologie Maritimes du Collège de France:** — Founded in 1859 by Prof. COSTE and now sponsored by the College of France at Paris. The purpose of the institution is to facilitate research in pure and applied marine biology. The 2-story building is well-equipped and the scientific work is under the direction of Dr. R. LEGENDRE. — *Cf.* Nature 29:16-17; Ann. Soc. Belg. Micro. 28:1-44; Revue Scientifique 70:750-53; DEAN 1894; SAND 1898; KOFOID 1910; MAGRINI 1927; VAUGHAN 1937.

Dinard (Ille et Vilaine): **Laboratoire Maritime du Museum National d'Histoire Naturelle:** — At the mouth of the River Rance, with pronounced tides. Founded in 1882 and now sponsored by the National Museum of Natural History of Paris for research in oceanography and marine biology. The two buildings contain a public aquarium, marine museum, library, and research laboratories. The station is open from June to September. — *Station publication:* Bulletin du Laboratoire Maritime de Dinard (1928-). — *Cf.* La Nature, Paris 16(2):186-88; Ann. Scient. Nat. Zool. 7(1):1-46; SAND 1898; KOFOID 1910; MAGRINI 1927; VAUGHAN 1937.

Endoume: **Laboratoire Marion de Marseille:** — Sponsored by the Faculty of Science of the University of Marseilles for instruction and research in marine zoology. The 3-story building contains a public aquarium, marine museum, classroom, and research laboratories. — *Station publication:* Travaux du Laboratoire de Zoologie et du Laboratoire Marion. — *Cf.* Ann. Musée d'Hist. Nat. Marseille 3:7-18; DEAN 1894; SAND 1898; KOFOID 1910; VAUGHAN 1937.

Le Croisic (Loire Inférieure): **Laboratoire de Biologie Maritime de Le Croisic:** — Accessible to sandy shores, salt marshes, and sand dunes. Founded in 1920 by Prof. ALPHONSE LABBÉ and now sponsored by the School of the Practice of Medicine and Pharmacy at Nantes. Station open to a maximum of eight investigators from July to September. — *Cf.* MAGRINI 1927; VAUGHAN 1937.

Le Lautaret (Hautes Alpes): **Institut de Botanique Alpine Marcel Mirande:** —

On a mountain pass in the western Alps at an elevation of 6,888 feet, the region containing about 2,000 species of plants. Founded in 1899 by Prof. LACHMANN and now sponsored by the University of Grenoble for the purpose of culturing alpine plants of different regions of the world and of studying their biology and propagation. There is a large alpine garden, a museum, library, and research rooms. The station is open from July first to September first. — *Cf.* Université de Grenoble Annales 32:1-31; La Nature, Paris 54(2):257-60.

Luc-sur-Mer (Calvados): **Laboratoire de Luc-sur-Mer de la Faculté des Sciences de Caen:**—Founded in 1874, the building now contains research laboratories, library, and marine aquarium. — *Cf.* SAND 1898; KOFOID 1910; MAGRINI 1927; VAUGHAN 1937.

Montpellier (Hér.): **Station Internationale de Géobotanique Méditerranéenne et Alpine:** — Founded in 1930 by an international committee of botanists and now directed by Prof. J. BRAUN-BLANQUET for the study of geobotany and the methods of phytosociology and ecology. The building contains well-equipped laboratories, herbarium, and library. The station is open from September to July, with facilities for work especially in the Alps during the summer months. — *Station publications:* Communications de la Station Internationale de Géobotanique Méditerranéenne et Alpine, Montpellier (1930-); Prospectus; Prodrome des Groupements Végétaux (1931-). — *Cf.* Rev. Bot. Appl. d'Agr. Col. 10:1-4; Chronica Botanica 1935; *Ibid.* 1936; *Ibid.* 1938 (on the new building).

Orédon (Hautes-Pyrénées): **Laboratoire Biologique du Lac d'Orédon:** — On the shore of a mountain lake at an altitude of 6,071 feet. Sponsored by the University of Toulouse to help scientific workers study mountain biology. The 2-story building contains laboratory and living accommodations. Open to investigators from July fourteenth to August thirteenth.

Roscoff (Finistère): **Station Biologique de Roscoff (Laboratoire Lacaze-Duthiers):** — Dedicated to research and instruction in marine biology and sponsored by the Faculty of Sciences of the University of Paris with an annual budget of 150,000 francs. Prof. CHARLES PÉREZ directs the work of the station, which consists of five buildings. These contain a herbarium, classroom, library, darkrooms, and well-equipped general and special laboratories. A 17-passenger bus and an 18-ton vessel, Dundee, are also attached to the station. Two courses are offered in marine biology. — *Station publications:* Travaux de la Station Biologique de Roscoff (1923-); Conditions d'Admission. — *Cf.* Arch. Zool. 1(3):1-38; *Ibid.* 1(6):311-62; *Ibid.* 1(9):543-62; Nature 29:16-17; Arch. Zool. 2(9):255-363; *Ibid.* 3(3):1-42; *Ibid.* 3(6):1-35; Ann. Soc. Belge Micr. 28:1-44; Science 28:479-80; Int. Rev. Hydrobiol. 1:282-88; *Ibid.* 2:493-97; L'Illustration 86(1):393-95; DEAN 1894; SAND 1898; JUDAY 1910; KOFOID 1910; MAGRINI 1927; VAUGHAN 1937; Bull. Soc. R. Bot. Belg. 46:224-249 (especially on phycological facilities).

Sète (Hérault): **Station Biologique de Sète:** — Founded in 1879 and now sponsored by the Institute of Zoology and General Biology of the University of Montpellier. The large, 2-story building contains a public aquarium, museum, classroom, library, living rooms, and several laboratories. — *Station publication:* Travaux de la Station de Sète. — *Cf.* DEAN 1894; SAND 1898; JUDAY 1910; KOFOID 1910; MAGRINI 1927; VAUGHAN 1937.

Tamaris-sur-Mer: **Station Maritime de Biologie de Tamaris:** — Sponsored by the Faculty of Sciences of the University of Lyon in order to study the flora and fauna of the region of Toulon. The large, Mooresque laboratory building is open to investigators from March fifteenth to May first and from June twentieth to October twentieth. — *Cf.* Bull. Soc. Amis de l'Univ. Lyon 11:244-56; SAND 1898; KOFOID 1910; MAGRINI 1927; VAUGHAN 1937.

Villefranche-sur-Mer (Alpes Maritimes): **Station Zoologique de l'Université de Paris à Villefranche-sur-Mer:** — On the shores of the Mediterranean Sea with an exceptional pelagic fauna, both in abundance and variety. Sponsored by the University of Paris to aid in research on different problems of marine biology. There is a well-equipped building for laboratory work and living accommodations. A 4-ton motorboat is available. Vacation course in marine biology offered during Easter recess. — *Station publication:* Travaux de la Station Zoologique de Villefranche-sur-Mer (1925-). — *Cf.* Arch. Sci. Phys. et Nat. 12:1-11; Ann. Soc. Belge Micr. 28:1-44; Int. Rev. Hydrobiol. 10:317-19; DEAN 1894; SAND 1898; JUDAY 1910; KOFOID 1910; MAGRINI 1927; VAUGHAN 1937.

Wimereux (Pas-de-Calais): **Station Zoologique de Wimereux:** — On the shore of the Straits of Dover and dedicated to research and instruction in zoology and botany. Established in 1874 by Prof. ALFRED GIARD and now sponsored by the Faculty of Sciences of the University of Paris with Prof. MAURICE CAULLERY as director. The laboratory buildings are open to investigators from April to October inclusive. — *Station publications:* Bulletin Biologique de la France et de la Belgique; Travaux de la Station Biologique de Wimereux (1879-). — *Cf.* Revue Scientifique 4:217-22; Revue de l'Enseignement des Sciences 1:329-38; Revue du Mois 6:385-99; DEAN 1894; SAND 1898; JUDAY 1910; KOFOID 1910; MAGRINI 1927; VAUGHAN 1937.

— *FRENCH INDO-CHINA* —

Cauda (Nhatrang, Annam): **Institut Océanographique de l'Indochine:**—In a region with rocky and sandy shores and coral reefs. Founded in 1922 and now sponsored by the Government-General of Indo-China for scientific researches in physical and biological oceanography and the establishment of a museum and aquarium. There is a well-equipped, 2-story building and the 147-foot research vessel, De Lanessan. — *Station publications:* Notes; Mémoires; Annual Report. — *Cf.* La Nature, Paris 65(1):452-53; MAGRINI 1927; VAUGHAN 1934; VAUGHAN 1937.

— *GERMANY** —

Bellinchen a. Oder: **Biologische Station Bellinchen:** — Located on the Oder River for the purpose of instruction and research in ecology and related subjects. Courses are given in faunistics, floristics, and ecology.

Dümmersee (near Osnabrück): **Forschungshütte des Landesmuseum Hannover:**— *Cf.* Chronica Botanica 1938.

Garmisch-Partenkirchen (Bayern): **Alpenlaboratorium auf dem Schachen bei Garmisch:** — At an altitude of 6,232 feet, this institution is sponsored by the Bavarian Ministry for Instruction and Culture and the Union for the Protection of Alpine Plants for the culture and study of alpine plants. Dr. F. C. v. FABER directs the work of the station, which is open to research workers from June fifteenth to October first.

Hallstatt: **Botanische Station in Hallstatt:** — A private laboratory sponsored by Dr. FRIEDRICH MORTON for investigating the natural history of Hallstatt and vicinity. Investigators may make use of the station's facilities. — *Cf.* Chronica Botanica 1:84; *Ibid.* 2:76; *Ibid.* 5:256.

Helgoland: **Biologische Anstalt auf Helgoland:** — An independent institution under the direction of Prof. A. HAGMEIER. The large, 6-story building contains workshops, darkrooms, culture rooms, offices, library, public aquarium, herbarium, class laboratories, and many research laboratories. The 112-foot research vessel, Makrele, is attached to the station. Four courses are given in marine biology. — *Station publications:* Helgoländer Wissenschaftliche Meeresuntersuchungen (1937-); Ordnung für Vergebung und Benutzung der Arbeitsplätze; Lehrveranstaltungen der Biologischen Anstalt.—*Cf.* Zool. Anz. 15:290-92; *Ibid.* 16:124-27; Bot. Centralblatt 54:139-42; Rept. Smithsonian Inst. for 1893:505-19; Wiss. Meeresuntersuch., Abth. Helgoland 1:1-36; Verh. Deutsch. Zool. Ges. 6:177-82; Verh. Zool.-Bot. Ges., Wien 47:47-54; Mitth. deutsch. Seefischerei-Ver. 15:107-19; Zeitschr. d. Ver. Deutsch. Ingen. 47:807-12; Zeitschr. f. Bauverwaltung 25:470-72; Naturwissenschaften 6:569-72; Der Fischerbote 11:184-88; Int. Rev. Hydrobiol. 10:727-39; Cons. Intern. Expl. Mer, Rapports et Procès-Verbaux des Réunions 47(3):17-33; Der Biologe 7(3):161-83; Westermanns Monatshefte 157:513-20; DEAN 1894; SAND 1898; JUDAY 1910; KOFOID 1910; MAGRINI 1927; VAUGHAN 1937.

Helgoland: **Vogelwarte Helgoland:** — Situated on the only island in a large area of the North Sea and consequently a frequent stopping place for migrating birds. Founded in 1909 for investigating the migration and protection of birds and for instruction in ornithology. The 2-story building contains bird collections, offices, library, classroom, and laboratories. There are bird-traps for banding in the adjacent gardens. A course is offered in ornithology. — *Cf.* Der V. Internat. Ornithol. Kongress 1910:564-75; Brit. Birds 27:284-89; Der Biologe 3(7):184-86; Vogelzug 7:35-50.

* Territorial boundaries as of March 1938 (*i.e.*, including Austria).

Husum (Schleswig-Holstein): **Zoologische Station.**

Kiel: **Institut für Meereskunde der Universität Kiel:** — Sponsored by the University of Kiel with Prof. A. REMANE as director. The 3-story building contains a number of well-equipped laboratories. — *Station publication:* Kieler Meeresforschungen (1936-37-). — *Cf.* Kieler Meeresforschungen 3:1-16; K. BRANDT, *Die* beiden Meereslaboratorien in Kiel (Conseil Perm. Int. pour l'Explor. de la Mer, 1926, pp. 16).

Kloster Hiddensee (Pommern): **Biologische Forschungsanstalt Hiddensee:** — Sponsored by the University of Greifswald and the Province of Pommern for instruction and research in the plant ecology and biology of the region. There is complete laboratory equipment, including an ornithological station. Vacation courses in ornithology, hydrobiology, and ecology are offered. — *Station publication:* Hydrobiologischer und Ökologischer Ferienkursus auf Hiddensee. — *Cf.* Chronica Botanica 1:145-46.

Krefeld: **Limnologische Station der Kaiser Wilhelm-Gesellschaft:** — Sponsored by the Kaiser Wilhelm-Gesellschaft and the City of Krefeld for the limnological examination of the lower Rhine waters. — *Station publication:* Natur am Niederrhein. — *Cf.* Zool. Anz. 80:336; Int. Rev. Hydrobiol. 22:128; Der Naturforscher 6(3):1-8; Chronica Botanica 1936; *Ibid.* 1938.

Langenargen: **Institut für Seenforschung und Seenbewirtschaftung der Kaiser Wilhelm-Gesellschaft:** — Located on the shore of Bodensee and sponsored by the Kaiser Wilhelm Institute for the purpose of freshwater investigation and instruction. Dr. HANS-JOACHIM ELSTER is director of the Institute, which is housed in a 3-story building. A 3-week course in limnology is offered each July. — *Cf.* Rivista di Biologia 2:550-52; Int. Rev. Hydrobiol. 9:235-36; *Ibid.* 15:258-63; Der Biologe 4:134-37; Arch. Hydrobiol. 33:164; Int. Rev. Hydrobiol. 38:512; LENZ 1927; RICKER 1937.

Lunz-am-See: **Biologische Station Lunz** (Kupelwiesersche Stiftung): — On the shores of Lunz Lake, a typical sub-alpine lake at an elevation of about 2,000 feet. Sponsored by the Academy of Sciences of Vienna and the Kaiser Wilhelm Institute for instruction and research in fresh-water and alpine ecology. Founded in 1906 by Dr. KARL KUPELWIESER and now directed by Dr. F. RUTTNER. The 2-story building contains work-shops, greenhouses, darkrooms, offices, library, and many laboratories. A 3-week course in hydrobiology is given each summer. — *Cf.* Die Umschau 10:944-47; Biol. Zbl. 26:463-80; Arch. Hydrobiol. 2:465-99; Int. Rev. Hydrobiol. 1:297-99; *Ibid.* 13:213; *Ibid.* 29:148-54; Naturwissenschaften 2:313-21; KOFOID 1910; JUDAY 1910; LENZ 1927; RICKER 1937; Abderhalden's Handb. 9, 2.

Plön (Holstein): **Hydrobiologische Anstalt der Kaiser Wilhelm-Gesellschaft:** — Located in a morainal lake district and dedicated to research in hydrobiology and limnology. Founded in 1892 by Dr. OTTO ZACHARIAS and now sponsored by the Kaiser Wilhelm Institute with Dr. A. THIENEMANN as director and Dr. FR. LENZ as director of scientific work. There is a well-equipped, 3-story building and a 32-foot motorboat. — *Cf.* Zool. Anz. 3(11):18-27; *Ibid.* 3(12):600-04, 655-56; Verh. Ges. dtsch. Naturf. Ärzte 63(11):120-21; Rev. biol. du Nord France 4:146-49; Zool. Anz. 15:36-39; Int. Rev. Hydrobiol. 1:507-09; SAND 1898; SCOURFIELD 1905; JUDAY 1910; KOFOID 1910; LENZ 1927; RICKER 1937.

Rossitten (Kurische Nehrung, Ostpreussen): **Vogelwarte Rossitten der Kaiser Wilhelm-Gesellschaft:** — On a great "migratory bridge" for birds near the Baltic Sea. Founded in 1901 and now sponsored by the Kaiser Wilhelm-Gesellschaft for research and instruction in ornithology. Dr. ERNEST SCHÜZ directs the work of the station, which is housed in four buildings and three field annexes. An elementary course in ornithology is offered early in October. — *Station publications:* Der Vogelzug; Lehrgang der Vogelwarte Rossitten. — *Cf.* Der Biologe 4:225-27; Vogelzug 9(2):70-90.

Saarbrücken: **Hydrobiologische Station:** — *Cf.* Int. Rev. Hydrobiol. 10:549-50; Rivista di Biologia 4:401-02.

Seeon (Chiemgau, Oberbayern): **Biologisches Laboratorium Seeon:** — A private laboratory sponsored by Prof. R. WOLTERECK for faunistic studies on differentiation of animal races in lakes and related habitats. Open to foreign investigators from April first to November first. — *Cf.* Int. Rev. Hydrobiol. 20:213-15.

Wasserburg (Bavaria): **Biologische Station Wasserburg am Bodensee:** — Sponsored by the Kaiser Wilhelm Institute (for some time directed by Dr. HELMUT GAMS) for researches in limnology and related subjects. — *Cf.* Int. Rev. Hydrobiol. 15:144; LENZ 1927.

— *GREENLAND* —

Godhavn (Disko Island): **Den Danske Arktiske Station:** — Well within the Arctic Circle (latitude: 69° 14′ N.) and near diversified arctic habitats. Founded in 1906 by Morton P. Porsild and now sponsored by the Government of Denmark for research in arctic science. The buildings contain good laboratory and living accommodations, a herbarium, and a library. Motorboats are available, as are sledges and camping equipment. The station is open throughout the year, being primarily a laboratory and not a base for travel. — *Station publication:* Arbejder fra den Danske Arktiske Station. — *Cf.* American Naturalist 39:505-06; Nature 108:320-21; Current History 16:637-41.

— *HAWAII* —

Honolulu: **Marine Biological Laboratory of the University of Hawaii:** — On the shore of Waikiki reef, a habitat rich in animal and plant forms. Established in 1920 and now sponsored by the University of Hawaii for instruction and research in marine biology. Prof. C. H. Edmondson directs the work of the station, the facilities of which are open to investigators between June and September. — *Cf.* Jour. Pan-Pacific Research Institute 6(2):6-9; Magrini 1927; Turtox 1937; Vaughan 1934; Vaughan 1937.

— *HUNGARY* —

Tihany: **Hungarian Biological Research Institute:** — On the shore of Lake Balaton, the largest lake in Central Europe. Established for biological investigations of the organisms living in the lake and general biological researches independent of local questions and sponsored by the Hungarian Ministry of Education. The station has an annual budget of 35,000 pengö. There are ten resident investigators, with Prof. Geza Entz as director. The 4-story laboratory building is unusually well-equipped. Extension courses are given for middle-school teachers in biology. — *Station publications:* A Magyar Biologiai Kutatointezet Munkai (Arbeiten des Ungarischen Biologischen Forschungs Institutes) (1927-); Prospectus (in English). — *Cf.* Ann. Biol. Lacustre 14:205-07; Arch. Balaton. 1:1-14; Nature 120: 968-69; Int. Rev. Hydrobiol. 13:370-72; *Ibid.* 18:435-36; Bull. Mus. Hist. Nat., Paris 33:468-69; Nature 121:93; Lenz 1927; Chronica Botanica 1935; *Ibid.* 1936.

— *INDIA* —

Calicut (South Malabar): **West Hill Marine Biological Station:** — On a narrow belt of low land lying between the sea and the lofty Western Ghat Mountains. Sponsored by the Madras Department of Fisheries for marine fishery research in general. — *Cf.* Vaughan 1937.

Ennur (Madras): **Ennur Biological Station:** — Sponsored by the Madras Department of Fisheries to supply biological specimens, although investigators may make use of the station's facilities. — *Cf.* Vaughan 1937.

Pamban (Krusadai Island, Madras): **Krusadai Marine Biological Station:** — The surrounding flora and fauna are among the richest in south India. Established in 1930 by the Madras Department of Fisheries for marine fishery research. The station is fairly well-equipped and there is the motor launch, The Pearl. — *Cf.* Vaughan 1937.

— *ITALY* —

Cagliari (Sardinia): **Stazione Biologica:** — *Cf.* Int. Rev. Hydrobiol. 12:434-35; Kofoid 1910; Juday 1910.

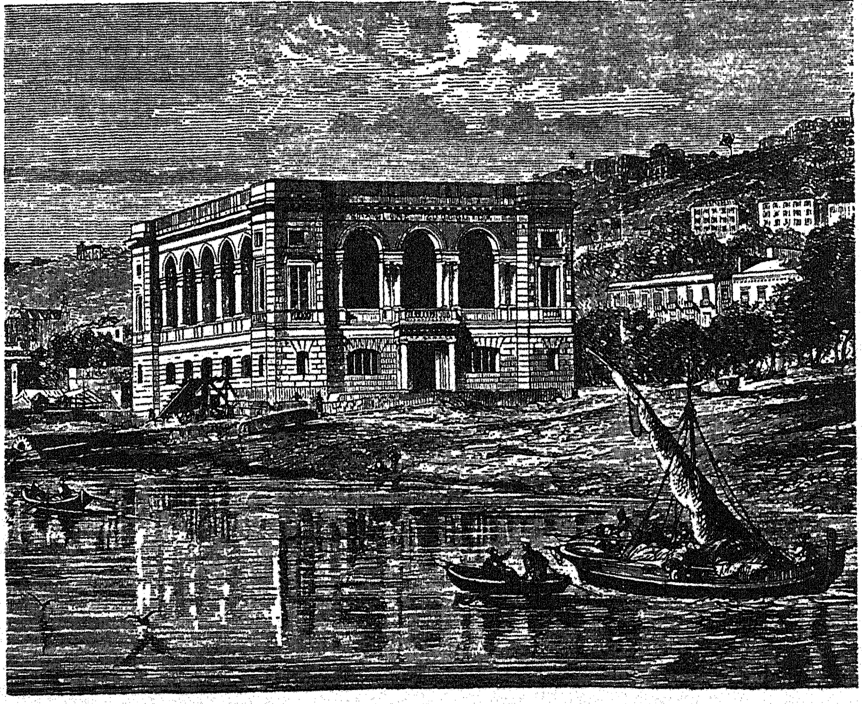
Col d'Olen (Alagna Sesia, Vercelli): **Istituto Scientifico Angelo Mosso sul Monte Rosa:** — In the Pennine Alps, at an altitude of 9,520 feet, with the cabin at Point Gnifetti at an altitude of 14,944 feet. Sponsored by the Royal University of Turin for scientific research in the mountains. The 3-story building contains laboratory and living accommodations. The institute is open during July and August. — *Station publication:* Atti del Laboratorio Angelo Mosso.

Messina (Sicily): **Istituto Centrale di Biologia Marina di Messina:** — Sponsored by the Royal Italian Oceanographical Committee for research in marine biology. — *Sta-*

tion publications: Memorie Istituto Centrale di Biologia Marina di Messina; Bolletino Istituto Centrale di Biologia Marina di Messina. — *Cf.* Revue Scientifique 55:381-86; MAGRINI 1927; VAUGHAN 1937.

Monte del Lago (Umbria): **R. Stazione Idrobiologica del Lago Trasimeno:** — Founded in 1922 by Prof. OSVALDO POLIMANTI and now sponsored by the Italian Ministry of Agriculture and Forestry to investigate the flora and fauna of the region. There is a 2-story laboratory building and a 25-foot motorboat. — *Cf.* Int. Rev. Hydrobiol. 9:546-50; *Ibid.* 11:565; Rivista di Biologia 6:566-74; Věda Přirodni 8:44-47; LENZ 1927; Chronica Botanica 1936.

Naples: **Stazione Zoologica di Napoli:** — On the Bay of Naples and dedicated to any kind of biological research by qualified investigators from any nation. Founded



DOHRN'S INTERNATIONAL ZOOLOGICAL STATION AT NAPLES, A SHORT TIME AFTER THE COMPLETION OF THE ORIGINAL BUILDING (*contemporary woodcut*).

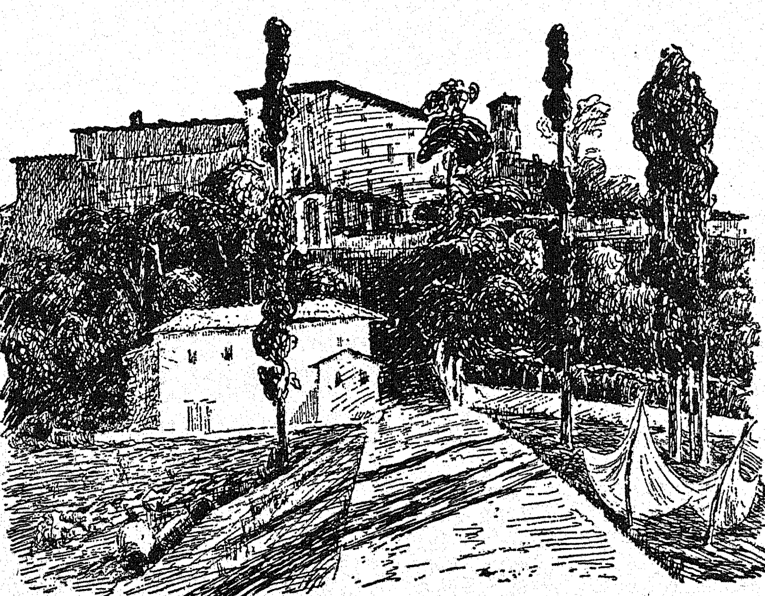
in 1870 by ANTON DOHRN, opened in 1874, with additions to building made in 1888 and 1903. Conducted as an autonomous institution with an annual budget of about 900,000 lire. Prof. REINHARD DOHRN heads the resident staff of five investigators. The 4-story building contains a public aquarium, supply department, public museum, dark-rooms, workshops, offices, library, herbarium, kitchen, and various kinds of well-equipped laboratories. The station can accommodate 65 investigators at one time. — *Station publications:* Pubblicazioni della Stazione Zoologica (continuing Mitteilungen aus der Zoologischen Station zu Neapel) (1916-); Fauna e Flora del Golfo di Napoli (1880-); Regulations for Prospective Investigators; Prezzi di vendita degli animali marini conservati; Guide to the Aquarium of the Zoological Station at Naples. — *Cf.* especially bibliography in KOFOID 1910; Nature 5:277-80, 437-40; *Ibid.* 6:362-63, 535-36; *Ibid.* 8:81; Science n.s. 1:479-81, 507-10; *Ibid.* 2:93-97; Nature 43:392-93; *Ibid.* 48:440-43; Science 1:238-39; *Ibid.* 3:16-18; American Naturalist 31:960-65; Science 5:832-34; Bot. Gaz. 23:278-82; Popular Science Monthly 59:419-29; Science 16:993-94; Die Umschau 2:116-18; Science 25:355-56; *Ibid.* 36:453-68; Popu-

lar Science Monthly 77:209-25; Science 52:323-25; Int. Rev. Hydrobiol. 10:739-40; Rivista di Biologia 5:788; Science 59:361; *Ibid.* 59:182-83; Rivista di Biologia 6:255-61; Int. Rev. Hydrobiol. 12:266-67; Science 61:585-86; *Ibid.* 63:271; Naturwissenschaften 14:412-24; Science 65:289-90; *Ibid.* 90:206; Dean 1894; Sand 1898; Juday 1910; Kofoid 1910; Magrini 1927; Vaughan 1937.

Pallanza: **Istituto Italiano di Idrobiologia Dott. Marco de Marchi:** — Supervised by the Ministry of National Education for research in limnology. — *Cf.* Rivista di Biologia 25:438.

Piccolo San Bernardo (Aosta): **Giardino Alpino "La Chanousia" e Lab. di Botanica Alpina "De Marchi":** — *Cf.* Chronica Botanica 1:200; *Ibid.* 1:219.

Rovigno d'Istria: **Istituto Italo-Germanico di Biologia Marina di Rovigno d'Istria:** — Established in 1870 at Trieste by Dr. O. Hermes and moved to present site in 1891. Now sponsored by the Royal Italian Oceanographic Committee and the Kaiser



A view of the Hydrobiological Station at the Lago Trasimeno, Umbria, Italy, seen from the landing (*drawing by V. Bauer*).

Wilhelm Institute for instruction and research in marine biology, especially of the Adriatic Sea. The 4-story building contains a public aquarium, scientific sales department, museum, herbarium, offices, and research laboratories. — *Station publications:* Note (or Notizen) (1932-); Thalassia (1938-); Announcement; Liste der abgebbaren Seetiere und-pflanzen für wissenschaftliche Institute und den biologischen Unterricht. — *Cf.* Zool. Anz. 16:356-71; *Ibid.* 16:401-04; Int. Rev. Hydrobiol. 1:297; *Ibid.* 3:258-61; Die Naturwissenschaften 22:1-8; Rivista di Biologia 2:546-49; Int. Rev. Hydrobiol. 10:551; *Ibid.* 10:739-40; Science 58:9; Dean 1894; Sand 1898; Juday 1910; Kofoid 1910; Magrini 1927; Vaughan 1937.

San Guiliano: **Laboratorio di Biologia Marina per il Mare Ligure:** — On the rocky beach of the Ligurian Sea. An autonomous institution owned by Professors Alessandro Brian and Renato Santucci to aid in the study of marine biology. — *Cf.* Int. Rev. Hydrobiol. 5:179-80; Arch. Zool. Ital. 23(9-10); Rivista di Biologia 22:535-48; Magrini 1927; Vaughan 1937.

Taranto: **Istituto Demaniale di Biologia Marina di Taranto:** — Sponsored by the National Research Council of the Ministry of National Education for research in general marine biology. Prof. Attilio Cerruti directs the work of the station, which is

housed in a 3-story, well-equipped building. The 33-foot vessel, Galeso, is available as are two motorboats and two sailboats. — *Cf.* Rivista di Biologia 3:379-90; Int. Rev. Hydrobiol. 10:196; *Ibid.* 29:294-95; Rivista di Biologia 15:386-90; MAGRINI 1927; VAUGHAN 1937.

— *JAMAICA* —

Cinchona: **Botanical Gardens:** — At various times these gardens have been used as an American biological station. *Cf.* VERDOORN, 1945, "Plants and Plant Science in Latin America", p. xxi: "Many botanists of today do not know of the early efforts to found an American Tropical Laboratory (*cf.* Bot. Gaz. 22:415 and 494, 1896, etc.), culminating in the establishment of a tropical biological station (in 1903) at Cinchona, Jamaica (*cf.* MAXON 1922, Smiths. Rept. for 1920, p. 529, etc.). — Still much less is known today of the grandiose plans of LUIGI BUSCAGLIONI, who planned a second 'hortus bogoriensis' on the Amazon (ca. 1900), traveling widely to obtain sympathy and support (for a pathetic account of his efforts *cf.* Nuovo Giorn. Bot. Ital. 9:1-32, 1902). — A plan to establish a British tropical research station at Jamaica has recently been developed by V. J. CHAPMAN (Nature 152:47, 1943)".

— *JAPAN* —

Akkeshi: **Akkeshi Marine Biological Station:** — On the sea front of the Gulf of Akkeshi with sandy beaches, rocky beaches, and a muddy bottom. Established in 1931 and sponsored by the Hokkaido Imperial University for research and instruction in biology. There is a 3-story building and a 26-foot motorboat, Misago. Course work is given in marine biology, marine invertebrate zoology, marine algae, experimental morphology, and physiology. — *Station publications:* Contributions from the Akkeshi Marine Biological Station; The Akkeshi Marine Biological Station (a guide printed in Japanese). — *Cf.* VAUGHAN 1937.

Asamushi (Aomori-ken): **Marine Biological Station of the Tohoku Imperial University:** — On the shore of Mutsu Bay, facing a shallow sea of about four fathoms in depth. Sponsored by the Faculty of Science of Tohoku Imperial University for research and instruction in marine biology. Founded in 1924 by Prof. SINKISHI HATAI and now directed by Prof. SANJI HOZAWA. The station contains a public aquarium, dormitories, library, classrooms, and well-equipped research laboratories. Three-week courses are given in marine biology, systematic botany, planktology, algology, comparative physiology, and seismology. — *Cf.* Records of the Oceanographic Works in Japan 1:26-38; VAUGHAN 1934; VAUGHAN 1937.

Fukushima (Kiso, Nagano Prefecture): **Kiso Biological Station:** — In a forested, mountainous region with torrential streams. Sponsored by Kyoto Imperial University to extend limnological researches to the life in streams and torrents.

Hunami-cho (Muroran, Hokkaido): **Institute of Algological Research:** — Founded in 1933 and now sponsored by Hokkaido Imperial University for research work on marine algae. Prof. Y. TAMADA directs the work of the institute which maintains laboratory and living accommodations. — *Station publication:* Reports from the Marine Station for Algological Research (in Japanese). — *Cf.* Chronica Botanica 1935; *Ibid.* 1936; VAUGHAN 1937.

Kannonji (Otsu, Shiga-ken): **Otsu Hydrobiological Station:** — On Biwa Lake, the largest in Japan, with a central basin about 100 meters in depth and surrounded by various types of shores. Founded in 1914 and now sponsored by the College of Science of Kyoto Imperial University for research and instruction in limnology and allied subjects. The 2-story building contains library, aquarium, offices, and laboratories. Courses given in physiology and freshwater biology. — *Station publication:* Contributions from the Otsu Hydrobiological Station. — *Cf.* Int. Rev. Hydrobiol. 28:350; LENZ 1927.

Kominato Bay (Chiba Prefecture): **Kominato Marine Biological Laboratory:** — On the rocky shores of Kominato Bay, the depth being 100 kilometers within four kilometers from shore. Sponsored by the Imperial Fisheries Institute for research and instruction in marine biology. — *Cf.* VAUGHAN 1937.

Misaki (Kanagawa Prefecture): **Misaki Marine Biological Station:** — Founded in 1885 by the College of Sciences of the Imperial University of Japan and now spon-

sored by the Imperial University of Tokyo for research and instruction in marine biology, oceanography, and allied sciences. The plant contains dormitories, aquarium, museum, seismographic apparatus, and many laboratories. Summer courses given in marine zoology. — *Station publication:* Journal of Faculty of Science, Section IV, Tokyo Imperial University. — *Cf.* Pop. Sci. Mon. 1904:195-204; SAND 1898; VAUGHAN 1934; VAUGHAN 1937.

Osshoro (Hokkaido): **Osshoro Marine Biological Station:** — *Cf.* VAUGHAN 1934.

Seto-Kanayama (Wakayama-ken): **Seto Marine Biological Laboratory:** — Established in 1922 by Prof. IWAJI IKEDA of Kyoto Imperial University for research work in marine biology and for the instruction of students at Kyoto Imperial University. The Laboratory is well-equipped and includes the use of the 19-ton collecting vessel, Nyusin Maru. Courses are given in anatomy, experimental zoology, algology, and elementary oceanography. — *Cf.* Records of Oceanographic Work in Japan 1(3):113-29; VAUGHAN 1934; VAUGHAN 1937.

Shimoda-machi (Shizuoka-ken): **Shimoda Marine Biological Station:** — Sponsored by the Tokyo University of Literature and Science for research and instruction. There is one laboratory building and several boats. Course work is given in zoology, botany, oceanography, and science education. — *Cf.* VAUGHAN 1937.

Susaki (Kamogun, Siduoka Prefecture): **Mitsui Institute of Marine Biology:** — Adjacent tide pools and rocky strands abound in a rich fauna and flora. Established in 1933 by Mr. TAKANAGA MITSUI for the study of marine biology and to afford facilities for the research workers at the station. It is an autonomous institution with an annual budget of 25,000 yen. The 2-story building contains an aquarium, museum, library, and well-equipped laboratories. Fellowships are awarded annually by the station to research workers who desire to investigate marine material at the station.— *Cf.* VAUGHAN 1937.

Tomioka (Amakusa, Kumamoto Ken): **Amakusa Marine Biological Laboratory:** — Sponsored by Kyushu Imperial University. — *Cf.* Records of the Oceanographic Works in Japan 1(2):78-89; VAUGHAN 1934; VAUGHAN 1937.

— *LATVIA* —

Riga: **Hydrobiologische Station der Lettländischen Universität:** — Founded in 1924 and now sponsored by the University of Latvia for research and instruction in hydrobiology. Prof. EMBRIK STRAND directs the work of the station, which is housed in one of the university buildings in Riga. There is a field annex at Kurland on Lake Usmaitenschen. — *Station publication:* Folia Zoologica et Hydrobiologica. — *Cf.* Int. Rev. Hydrobiol. 12:435; *Ibid.* 21:478-80; LENZ 1927; VAUGHAN 1937.

— *MANCHUKUO* —

Harbin: **Sungari River Biological Station:** — *Cf.* LENZ 1927.

— *MARTINIQUE* —

Fort de France: **Museum et Laboratoire Océanographique de M. Conseil:** — *Cf.* MAGRINI 1927.

— *MEXICO* —

Pátzcuaro (Michoacán): **Estación Limnológica:** — On Lake Pátzcuaro at an altitude of over 6,000 feet. Sponsored by the Division of Fisheries of the Department of Marine of the Mexican Government to investigate the facilities of the lake as a center of fishing and to make a general survey of the lake. Mr. MANUEL ZOZAYA is director and Dr. FERNANDO DE BUEN is scientific advisor. There are ample laboratory and living facilities. — *Cf.* The Collecting Net 15:202.

— *MONACO* —

Monaco-ville: **Musée Océanographique et Aquarium de Monaco:** — On the Mediterranean Sea, with the shore sloping abruptly to deep water, often 300 to 500 meters in depth within three miles from shore. Founded in 1899 by ALBERT I, Prince of

Monaco, for original research in marine subjects and public education in oceanography. It is an autonomous institution, being a part of the Institute of Oceanography at Paris. Dr. JULES RICHARD is director of the institution, which has an annual budget of 1,300,-000 francs. The large, 4-story building contains a large public museum of oceanography, public aquarium, library, offices, darkrooms, and well-equipped laboratories. The 25-ton, 54-foot steamer, Eider, is available for collecting. The station is open from October first to July twenty-fifth. — *Station publications:* Bulletin de l'Institut Océanographique (1904-); Les Résultats des Campagnes Scientifiques de S.A.S. Prince Albert Ier de Monaco (1889-); Règlement Général Concernant l'Admission des Travailleurs faisant des Recherches; Musée Océanographique et Aquarium de Monaco (Guide Illustré). — *Cf.* Int. Rev. Hydrobiol. 1:504-07; Science 63:468-69; JUDAY 1910; KOFOID 1910; MAGRINI 1927; VAUGHAN 1937.

— *MOROCCO* —

Rabat: **Institut Scientifique Chérifien:** — Sponsored by the Direction of Public Education of Morocco for scientific research in French Morocco. Dr. J. DE LÉPINEY directs the work of the station, which has an annual budget of 650,000 francs. — *Cf.* Chronica Botanica 1936.

— *THE NETHERLANDS* —

Abcoude: **Laboratory of the Hugo de Vries Foundation:** — *Cf.* LENZ 1927; Chronica Botanica 1935; *Ibid.* 1936.

den Helder: **Zoölogisch Station der Nederlandsche Dierkundige Vereeniging:** — At the mouth of the Zuiderzee, close to the large sandflat area of northern Holland. Founded in 1876 and now sponsored by the Netherlands Zoological Society and the Netherlands Ministry of Education, Arts, and Sciences for marine biological investigations in the widest sense of the term. Dr. J. VERWEY directs the work of the station, which has an annual budget of 12,700 guilders. The 2-story building contains a public aquarium, library, office, classroom, and well-equipped laboratories. There is also a building with living accommodations. The 43-foot vessel, Max Weber, is available for collecting. — *Cf.* Arch. Zool. 1(6):312-19; Nature 29:16-17; Tijdschr. Nederl. Dierk. Vereen. 3:309-16; Feuille des Jeunes Natur. 19:17-19; Tijdschr. Nederl. Dierk. Vereen. 2(19):21-45; DEAN 1894; SAND 1898; JUDAY 1910; KOFOID 1910; VAUGHAN 1937.

Wijster (Drenthe): **Biologisch Station te Wijster:** — In the most extensive heath- and moor-land district of the Netherlands. Founded in 1927 by Dr. W. BEIJERINCK and now sponsored by the Netherlands Biological Station, an autonomous institution. There is good equipment for field research. — The scientific work originating from the station is marked, Mededeelingen van het Biologisch Station te Wijster. — *Cf.* Botany in the Netherlands, Sixth Int. Bot. Congr. 1935:80; Vakl. Biol. 19(2):17-25.

— *NETHERLANDS EAST INDIES* —

Batavia (Java): **Laboratorium voor het Onderzoek der Zee:** — Adjacent to salt- and brackish-water communities, coral reefs, and mangrove. Sponsored by the Netherlands East Indies Government and managed by the Botanical Gardens of Buitenzorg for scientific marine investigations. There are ample laboratory facilities. — *Cf.* Int. Rev. Hydrobiol. 10:195-96; Annales du Jardin Botanique de Buitenzorg 45:121-28; Natuurkundig Tijdschrift voor Nederlandsch-Indië 97:111-20; VAUGHAN 1934; VAUGHAN 1937.

Buitenzorg (Java): **Treub Laboratory** (Visitors' Laboratory) **of the Govt. Botanical Gardens:** — In the midst of the tropical lowland vegetation of 's Lands Plantentuin. Founded in 1884-85 by Prof. M. TREUB and now sponsored by the Botanical Gardens of Buitenzorg for use by foreign scientists who want to do laboratory work in the Botanical Gardens. — *Cf.* Bot. Ztg. 42:752-61, 768-80, 784-91; Pop. Sci. Mon. 67:579-89; Science 80:33-34; Ann. Jard. Bot. Buitenz. 45:1-60; Chronica Botanica 1935; *Ibid.* 1936; "Science and Scientists in the Netherlands Indies," p. 59, 1945.

Tjibodas (near Sindanglaija, W. Java): **Mountain Gardens and Biological Laboratory of the Govt. Botanical Gardens:** — Near the virgin forest (elevation between

4,500 and 9.800 feet). Founded in 1891 by Prof. M. TREUB and now sponsored by the Botanical Gardens of Buitenzorg. Laboratory and living accommodations are available. — *Cf.* Revue générale Scientifique 46:631-37, 664-68; Chronica Botanica 1935; "Science and Scientists in the Netherlands Indies," p. 403, *seq.*, 1945.

—*NEW CALEDONIA*—

Nouméa: **Marine Station:** — *Cf.* VAUGHAN 1934.

—*NEW ZEALAND*—

Portobello: **Portobello Marine Biological Station:** — Sponsored by the government of New Zealand for the study of New Zealand marine life. The buildings contain a public aquarium, library, scientific sales department, and laboratories. — *Cf.* VAUGHAN 1937.

—*NORWAY*—

Drøbak: **Universitets Biologiske Stasjon, Drøbak:** — Established in 1892 and now sponsored by the University of Oslo for marine research. Prof. HJALMAR BROCH directs the work of the station, which is housed in a 3-story building. Station open during July and August to students and investigators. — *Cf.* Dtsch. med. Wschr. 20:879; Nyt Mag. Naturv. 42:32; DEAN 1894; SAND 1898; JUDAY 1910; KOFOID 1910; MAGRINI 1927; VAUGHAN 1937.

Herdla: **Bergens Museums Biologiske Stasjon:** — Types of all prominent ecological habitats of the Norwegian Coast can be reached from this station within two hours. Founded in 1891 and now sponsored by the Bergen Museum for instruction and research in marine biology. Prof. AUGUST BRINKMANN is director of the station which has an annual budget of 25,000 Kroner. The 2-story building contains classrooms, living quarters, library, and several kinds of laboratories. The 48-foot vessel, Herman Friele, is available for research. — *Cf.* Bergens Museums Aarsberetning 1890(5):1-31; Bergens Museums Aarbok 1892(5):1-8; Zool. Anz. 16:217-20; Int. Rev. Hydrobiol. 1:299-300; Nature 111:358; Science 58:24-25; Int. Rev. Hydrobiol. 11:221; Bergens Museums Aarbok 1921-22(1):1-28; Bergens Museums Aarsberetning 1931-32:58-60; DEAN 1894; SAND 1898; JUDAY 1910; KOFOID 1910; VAUGHAN 1937.

Tromsø: **Biological and Hydrographic Laboratory of the Tromsø Museum:** — Established in 1930 by Mr. T. SOOT-RYEN and sponsored by the Tromsø Museum for scientific marine investigations in northern Norway. Space is available in the building of the Tromsø Museum and the 38-foot Sparre Schneider is available. — *Cf.* VAUGHAN 1937.

Trondheim: **Trondheims Biologiske Stasjon:** — An autonomous institution, subsidized by the Norwegian Government for the purpose of making hydrographical and biological investigations in the fiords and coasts of Norway. — *Cf.* Ann. Mag. Nat. Hist. 12:341-67; *Ibid.* 13:112-33, 150-64, 267-83; *Ibid.* 15:476-94; VAUGHAN 1937.

—*PANAMA (CANAL ZONE)*—

Gatun Lake: **Barro Colorado Island Biological Laboratory:** — On an island (six miles square with over 25 miles of shore line) largely covered with primeval rain forest (lower tropical zone). Established in 1924 and now sponsored by the Board of Directors of the Canal Zone Biological Area. Investigators desiring to visit the laboratory must obtain credentials from the Directors; this entitles them to secure steamship concessions, a pass on the Panama Railroad, and other privileges.—*Station publication:* Annual Report of the Barro Colorado Island Biological Laboratory (1926-). — *Cf.* Science 59:521-22; Jour. Hered. 15:99-112; Nation's Health 6(7):489-90; Science 62:111; Report of the Smithsonian Institution for 1926:327-42; Science 72:457; Nature Mag. 15:11-15; Atlantic Monthly 145:749-58; Wilson Bull. 42:225-32; Bull. Pan-American Union 67:43-51; Entomologist 66:217-21; Travel 63(2)15-19; Revue des Deux Mondes 25:30-34; Survey Graphic 24(4):192-93; Scientific Monthly 47:364-69.

—*PHILIPPINE ISLANDS*—

Puerto Galera (Island of Mindoro): **Puerto Galera Marine Biological Laboratory of the University of the Philippines:** — Sponsored by the Univ. of the Philippines

to provide biologists place and equipment for carrying out investigations on marine animals and plants. Mr. HILARIO A. ROXAS directs the work of the station, which offers both laboratory and living accommodations to students and investigators. — *Cf.* Int. Rev. Hydrobiol. 5:183; *Ibid.* 6:325-34; VAUGHAN 1934; VAUGHAN 1937.

— *POLAND* —

Hel: **Station Maritime de Hel:** — Founded in 1932 and now sponsored by the Ministry of Public Instruction and the Ministry of Commerce. — *Cf.* Chronica Botanica 1936.

Pińsk: **Poleska Stacja Biologiczna w Pinsku:** — In a vast marshy plain among many slow-running rivers. Sponsored by the Nencki Institute of Biology to study the limnological problems of rivers and marshes. Dr. JERZY WISZNIEWSKI directs the work of the station, which is housed in a 2-story building. A vacation course in hydrobiology is given. — *Cf.* Archives d'Hydrobiologie et d'Ichthyologie 10(4):431-34, 434-36; Chronica Botanica 1938.

Suwalki: **Stacji Hydrobiologicznej na Wigrach:** — On the shores of Lake Wigry, one of a group of more than 20 post-glacial lakes in the area. Sponsored by the Ministry of Education for the study of freshwater problems. Dr. ALFRED LITYŃSKI directs the work of the station, which has an annual budget of 30,000 zloty. A course is given in theoretical limnology. — *Station publication:* Archiwum Hydrobiologyi i Rybactwa (1926-). — *Cf.* LENZ 1927.

— *PORTUGAL* —

Dafundo: **Aquário Vasco da Gama—Estação de Biologia Maritima:** — Supported by the Fisheries Administration of the Ministry of Marine for general marine research on the coast of Portugal. There is a public aquarium, well-equipped laboratories, and the 135-ton research ship, Albacora. — *Station publication:* Travaux de la Station de Biologie Maritime de Lisbonne. — *Cf.* MAGRINI 1927; VAUGHAN 1937.

Porto: **Station de Zoologie Maritime "Augusto Nobre".**

— *RHODES* —

Rodi: **Istituto di Ricerche Biologiche in Rodi:** — An island in the Aegean Sea at the eastern end of the Mediterranean. Founded in 1936 and now sponsored by several Italian governmental agencies for research in the oceanographical, biological, and chemical sciences. The modern, 2-story building contains a large public aquarium, museum, library, and research laboratories. — *Cf.* VAUGHAN 1937.

— *ROUMANIA* —

Agigea: **Statiunea Zoologica Maritima "Regele Ferdinand I":** — Sponsored jointly by the Roumanian Ministry of National Education and the Laboratory of Zoology of the University of Iaşi for investigating the fauna of the Black Sea and neighboring lakes. Prof. C. MOTAS directs the work of the station, which is housed in a 2-story building. Station open from June first to October first.—*Station publication:* Lucrările Statiei Zoologice Maritime "Regele Ferdinand I" dela Agigea (1938-). — *Cf.* Ann. Soc. Univ. Jassy 19:1-16; Buletinuel Soc. Natur. din România 11:1-6; Ann. Scient. de l'Univ. de Jassy 23(2):1-4; VAUGHAN 1937.

Mamaia: **Statiunea Bio-oceanografica dela Mamaia.**

Sinaia (Cumpatul): **Statiunea Zoologica din Sinaia:** — At an elevation of 2,788 feet in a forested zone with much rainfall. Sponsored by the Ministry of National Education for the study of the fauna and flora of the region of Mount Bucegi. Prof. A. POPOVICI-BAZNOSANU directs the work of the station, which is open from June first to November first. — *Cf.* LENZ 1927.

Stâna de Vale (Bihor): **Statiunea Botanica Stâna de Vale:** — Sponsored by the Botanical Institute of the University of Cluj for biological studies on the flora and vegetation of the Bihor Mountains and the cultivation of alpine plants at an altitude of 3,608 feet. A course is given in phytosociology. The station is open during July and August.

— *SCOTLAND* —

Millport (Buteshire): **Marine Biological Station of the Scottish Marine Biological Association:** — Founded in 1884-85 by Sir JOHN MURRAY and now sponsored by the Scottish Marine Biological Association to investigate the flora and fauna of the Clyde Sea area and provide facilities for research and study for students and others interested in such work. RICHARD ELMHIRST directs the work of the station, which has an annual budget of £4,261. The 2-story buildings contain a public aquarium, museum, offices, storeroom for sales department, library, classroom, and many well-equipped laboratories. The 40-foot vessel, M. B. Nautilus, is available and is equipped with a laboratory for three persons. Several courses are given. — *Station publications:* Annual Report of the Scottish Marine Biological Association; Price List of Specimens. — *Cf.* Jour. Marine Biol. Assoc. United Kingdom 1:218-43; Nature 72:456; JUDAY 1910; KOFOID 1910; MAGRINI 1927; VAUGHAN 1937.

— *SPAIN** —

Chico: **Estación de Biología Marítima.**

Las Palmas (Canary Islands): **Laboratorio Oceanográfico de Canarias:** — Sponsored by the Spanish Institute of Oceanography for the systematic investigation of the oceanographic and biological conditions in the vicinity of the Canary Islands. — *Cf.* Instituto Espan. Oceanogr. Notas y Resúmenes 2(48):1-79; VAUGHAN 1937.

Málaga: **Laboratorio de Málaga — Instituto Español de Oceanografía:** — Founded on the Strait of Gibraltar in 1914 by Prof. ODÓN DE BUEN and now sponsored by the Spanish Institute of Oceanography for research in marine biology and oceanography. — *Cf.* VAUGHAN 1937.

Palma (Island of Mallorca, Balearic Islands): **Laboratorio Oceanográfico de Palma de Mallorca:** — Founded in 1906-07 by Prof. ODÓN DE BUEN and now sponsored by the Spanish Institute of Oceanography. The station is equipped with aquarium, museum, library, and several laboratories. — *Cf.* Bull. Soc. Zool. France 33:1-11; Int. Rev. Hydrobiol. 30:385-86; KOFOID 1910; MAGRINI 1927; VAUGHAN 1937.

San Sebastian: **Sociedad de Oceanografía de Guipuzcoa:** — *Cf.* MAGRINI 1927; VAUGHAN 1937.

Santander: **Laboratorio de Santander — Instituto Español de Oceanografía:** — Sponsored by the Spanish Institute of Oceanography to study the flora and fauna of the coastal regions of the Bay of Biscay. — *Cf.* KOFOID 1910; MAGRINI 1927; VAUGHAN 1937.

Valencia: **Laboratorio de Hidrobiología:** — *Cf.* Int. Rev. Hydrobiol. 7:272-73; LENZ 1927.

Vigo: **Laboratorio de Vigo — Instituto Español de Oceanografía:** — *Cf.* VAUGHAN 1937.

— *SURINAM (Neth. Guiana)* —

Paramaribo: **Biological Station at the General Agricultural Experiment Station:** — Established in 1903 under the directorship of C. J. J. VAN HALL. The present director, Dr. G. STAHEL, is anxious to help visiting biologists. Modern laboratory facilities. *Cf.* Bot. Gaz. 36:238-239; Bot. Cbl. 92:371; West-Ind. Gids, June 1920.

— *SWEDEN* —

Abisko: **Abisko Naturvetenskapliga Station:** — *Cf.* Chronica Botanica 1935.

Aneboda (Ugglehult): **Limnologiska Laboratoriet i Aneboda:** — Founded in 1907-08 and now sponsored by the University of Lund for research and instruction in limnology. A small, 2-story building contains apparatus for limnological research. — *Cf.* Int. Rev. Hydrobiol. 1:745-46; *Ibid.* 2:331-32; *Ibid.* 22:272; LENZ 1927.

Barsebäckshamn: **Barsebäckshamns Havsbiologiska Station:** — On the Oresund Sound, with brackish water on the surface and salt water beneath. Founded in 1914 and now sponsored by the Zoological Institute of the University of Lund for research and instruction in marine biology. A course in marine biology is given at the station, which is open to investigators during June, July, and August. — *Station publication:*

* As of June 1936.

Kungl. Fysiografiska Sällskapets Handlingar, Lund, Series: Undersökningar över Oresund. — *Cf.* Chronica Botanica 1936.

Fiskebäckskil: **Kristinebergs Zoologiska Station:** — Near the mouth of Gullmar Fiord, a relatively deep bay with a belt of islands near its mouth. Established in 1877 by Prof. SVEN LOVÉN and now sponsored by the Royal Swedish Academy of Science for research and instruction in marine zoology. Prof. EINAR LÖNNBERG directs the work of the station, which has an annual budget of 27,262 kronen. The equipment includes a library, aquarium, darkrooms, living accommodations, several laboratories, and the 42-foot motorboat, Sven Lovén. Course work in marine zoology is given.— *Cf.* Natural Science 7(6):407-16; Ark. f. Zool. 4(5):1-136; Popular Science Monthly 76:125-35; SAND 1898; JUDAY 1910; KOFOID 1910; Chronica Botanica 1936; VAUGHAN 1937.

Fiskebäckskil: **Klubbans Biologiska Station:** — At the mouth of the Gullmar Fiord (with a maximum depth of 394 feet) on the coast of the Skagerak. Established by the University of Uppsala for instruction of university students in marine zoology. Prof. SVEN EKMAN directs the work of the station, which is solely to offer course work in marine zoology to university students. — *Cf.* VAUGHAN 1937.

Göteborg: **Oceanografiska Institutionen vid Göteborgs:** — Sponsored by the Royal Society of Göteborg for research and instruction in physical oceanography and related sciences. Dr. HANS PETTERSSON directs the scientific work of the station, which is housed in a new, 2-story building. Special equipment includes a hydrodynamic tank (17 × 2 × 1 meters) and a plankton shaft (2 meters in diameter and 12 meters in length). The station is not open during July and August. — *Station publication:* Meddelanden fran Oceanografiska Institutet vid Göteborg (1939-). — *Cf.* Nature 145:698; VAUGHAN 1937.

— *SWITZERLAND* —

Bourg St. Pierre (Valais): **La Linnaea—Jardin et Laboratoire Alpins:** — In a valley of the Alps at an altitude of 5,576 feet, the region containing a mixture of both an arctic and Mediterranean flora. Founded in 1883, and now sponsored by the Institute of General Botany of the University of Geneva for research and instruction in alpine botany. Prof. FERDINAND CHODAT directs the work of the station, which consists of a botanical garden with 2,000 species of alpine plants and a laboratory building. A course is given in the botany of the Alps. The station is open during July and August. — *Station publication:* La Linnaea — Jardin et Laboratoire Alpins (an announcement in French). — *Cf.* Chronica Botanica 1936.

Davos: **Hydrobiologisches Laboratorium der Landschaft Davos:** — *Cf.* LENZ 1927; Chronica Botanica 1936.

Interlaken: **Alpengarten und Laboratorium "Schynige Platte":** —*Cf.* Chronica Botanica 1935.

Jungfraujoch (Berner Oberland): **Hochalpine Forschungsstation Jungfraujoch:** — In a high, mountainous region at an elevation of 11,340 feet. Established by an autonomous council to enable research work in all branches of science to be carried out under the best possible conditions in a high mountain region. Prof. A. V. MURALT directs the work of the station, which has an annual budget of 24,000 Swiss francs. The 5-story building constructed in solid rock contains living quarters, darkrooms, library, lecture-room, workshop, and several well-equipped laboratories. Application for permission to work at the station must be made through one of the participating societies (Schweizerische Naturforschende Gesellschaft; Kaiser Wilhelm-Gesellschaft, Berlin; Université de Paris; Royal Society, London; Akademie der Wissenschaften, Wien; Fonds National de la Recherche Scientifique, Bruxelles; Rockefeller Foundation, New York; and Jungfraubahn-Gesellschaft, Berne). Investigators whose applications are approved receive a reduction in railway fares and exemption from customs duty on consignments of scientific apparatus entering Switzerland. — *Station publication:* Information and Regulations. — *Cf.* Chronica Botanica 1935.

Kastanienbaum (Horw): **Hydrobiologisches Laboratorium der Naturf. Gesellschaft Luzern:** — *Cf.* Arch. f. Hydrobiol. 10:113-18; Int. Rev. Hydrobiol. 9:236; Chronica Botanica 1935; *Ibid.* 1939; LENZ 1927.

Zürich: **Geobotanisches Forschungsinstitut Rübel:** — Established in 1918 by Dr. E. RÜBEL and now an autonomous institution for studies in plant taxonomy and ecology. The headquarters and equipment are at Zürich, but the course in the ecology of alpine

vegetation is given at Davos. — *Station publications:* Bericht über das Geobotanische Forschungsinstituts Rübel in Zürich; Veröffentlichungen des Geobotanischen Forschungsinstituts Rübel in Zürich.

— *TUNISIA* —

Salammbó: **Station Océanographique de Salammbó:** — Sponsored by the Direction Générale des Travaux Publics in Tunis to investigate the marine organisms along the coast of Tunisia. The equipment includes a public museum and aquarium, library, and several laboratories. — *Station publications:* Notes de la Station Océanographique de Salammbó; Bulletin de la Station Océanographique de Salammbó; Annales de la Station Océanographique de Salammbó; Illustrated Catalogue of the Museum and Aquarium. — *Cf.* Science 63:488; Magrini 1927; Vaughan 1937.

— *UNION OF SOCIALIST SOVIET REPUBLICS* —

Alt-Peterhof: **Hydrobiological Section of the Scientific Institute at Peterhof:** — Sponsored by the Ministry of Education for hydrobiological and hydrochemical investigation of animals. — *Station publication:* Travaux de l'Institut des Sciences Naturelles de Peterhof (1925-). — *Cf.* Chronica Botanica 1936; Lenz 1927.

Archangel: **Algological Research Station:** — *Cf.* Chronica Botanica 1936.

Cherson: **All-Ukrainian Scientific-Practical Station of the Black and Asov Seas:** — Founded in 1918 and now sponsored by the Ministry of Agriculture of the Ukraine Republic. — *Station publications:* Bulletin der Allukrainischen wissenschaftlich-praktischen Staatsstation des Schwarzen und des Azowschen Meeres; Arbeiten der Allukrainischen wissenschaftlich-praktischen Staatsstation des Schwarzen und des Azowschen Meeres (1925-). — *Cf.* Lenz 1927.

Elenowka (Armenia): **Sewan Lake Station:** — On Lake Goktscha in the Caucasus Mountains. Sponsored by the Ministry of Agriculture of the Armenian Republic for theoretical and practical investigations of Lake Goktscha. — *Station publication:* Arbeiten der Sewanseestation. — *Cf.* Lenz 1927.

Kossino: **Biological Station at Kossino:** — Founded in 1908 and now sponsored jointly by the Moscow Society of Nature Research and the Ministry of Education for theoretical investigations in biology. Prof. L. Rossolimo directs the work of the station, which is housed in a 2-story building. — *Station publication:* Arbeiten der Biologischen Station zu Kossino (1924-). — *Cf.* Int. Rev. Hydrobiol. 17:386-87; *Ibid.* 25:303-04; Progressive Fish Culturist 34:12-14; Lenz 1927.

Kostroma: **Biological Station of the Scientific Society for the Investigation of the Kostroma Region:** — Founded in 1919 and now dedicated to theoretical research work on the Volga River. — *Station publication:* Arbeiten der Wissenschaftlichen Gesellschaft zur Erforschung des Lokalgebietes Kostroma. — *Cf.* Lenz 1927.

Krasnoyarsk (Siberia): **Siberian Ichthyological Laboratory:** —Sponsored by the Ministry of Agriculture for practical and theoretical investigations. — *Station publication:* Report of the Ichthyological Laboratory in Siberia. — *Cf.* Int. Rev. Hydrobiol. 11:391-92; Lenz 1927.

Lake Glubokoje: **Hydrobiological Station on Lake Glubokoje:** — Founded in 1888 and now managed by the Biological Station at Kossino for the Moscow Society of Naturalists. — *Station publication:* Arbeiten der Hydrobiologischen Station am See Glubokoje (1900-). — *Cf.* Trav. Soc. Imp. Acclim. 2:201-06; Kofoid 1910; Lenz 1927.

Maritui: **Baikal Hydrobiological Station:** — On Lake Baikal, one of the deepest lakes in the world (with a reputed depth of 4,725 feet). Sponsored by the Russian Academy of Sciences for theoretical and practical investigations. — *Station publication:* Arbeiten der Kommission für die Erforschung der Baikalsees. — *Cf.* Lenz 1927.

Mount Elbrus (Caucasus): **Institute of Research in High Altitudes:** — *Cf.* Science 87:550.

Murman: **Biological Station of the Academy of Sciences of the U. S. S. R. at Murman:** — On the Arctic Ocean which, owing to the penetration of the warm waters of the Atlantic, has an extremely rich and diverse fauna. Established in 1881 near Archangel, moved to near present site in 1899, and an announcement made in 1937 of plans to build a new station in the region to cost three and one-half million rubles. Sponsored by the Academy of Sciences of the U. S. S. R. with Prof. S. A. Zernov as

director. — *Cf.* Zool. Anz. 29:704-07; Ohio Naturalist 8:340-42; Int. Rev. Hydrobiol. 2:499-502; *Ibid.* 11:222-23; Science 67:158-59; *Ibid.* 85:536; Nature 139:725; DEAN 1894; SAND 1898; JUDAY 1910; KOFOID 1910; VAUGHAN 1937.

Murom, Vladimir: **Oka Biological Station:** — Founded in 1918 and now sponsored by the Ministry of Education for theoretical and practical biological investigations. — *Station publication:* Arbeiten der Biologischen Oka-Station (Murom-Russland). — *Cf.* LENZ 1927.

Novorossiisk: **Novorossiisk Biological Station:** — Sponsored by the People's Commissariat of Education to investigate the practical problems and objects of the Black Sea. Mr. W. A. WODJANITZKY directs the work of the station, which has an annual budget of 66,200 rubles.—*Station publication:* Arbeiten der Biologischen Noworossijsk-Station. — *Cf.* LENZ 1927; VAUGHAN 1937.

Otusy (Krim) : **Scientific Station of the Moscow Nature Research Society:** — *Cf.* Chronica Botanica 1935.

Perm: **Biological Station at Perm on the Kama River:** — Sponsored by the Biological-Scientific Research Institute of the University of Perm. — *Station publication:* Bulletin de l'Institut des Recherches biologiques et de la Station Biologique à l'Université de Perm. — *Cf.* LENZ 1927.

Petrosavodsk: **Borodin Hydrobiological Research Institute:** — *Cf.* KOFOID 1910; LENZ 1927.

Preobrazenie (Siberia) : **Algological Research Station:** — *Cf.* Chronica Botanica 1935.

Saratov: **Volga Biological Station at Saratov:** — Founded in 1900 and now directed by Dr. A. BEHNING for scientific investigation of the life of the Volga and educational work in hydrobiology. Course work is given to students. — *Station publications:* Arbeiten der Biologischen Wolgastation (1900-); Monographien der Biologischen Wolgastation (1924-). — *Cf.* Int. Rev. Hydrobiol. 3:461-62; *Ibid.* 5:581-93; Rivista di Biologia 5:789-90; Int. Rev. Hydrobiol. 13:111-13; *Ibid.* 17:357-61; Rev. Algol. 4:77-80; JUDAY 1910; KOFOID 1910; LENZ 1927.

Sevastopol: **Sevastopol Biological Station:** — Sponsored by the Academy of Sciences of the U. S. S. R. for oceanographical and hydrobiological observations of the Black and Asov seas. The 3-story building contains a public aquarium, library, darkroom, and several well-equipped laboratories. Course work is given to university students. — *Station publication:* Memoirs of the Sevastopol Biological Station. — *Cf.* Bull. Biol. 1:280-85; Int. Rev. Hydrobiol. 1:861-63; *Ibid.* 9:555; DEAN 1894; SAND 1898; JUDAY 1910; KOFOID 1910; VAUGHAN 1937.

Starosselje (Ukraine) : **Biological Station of the Dnieper:** — Founded in 1907 and now sponsored by the All-Ukraine Academy of Sciences for theoretical investigation of the Dnieper basin. — *Station publication:* Travaux de la Station Biologique du Dnieper (1926-). — *Cf.* LENZ 1927.

Swenigorod: **Hydrophysiological Station at Swenigorod on the Moskva:** — Sponsored by the National Scientific Institute of the Ministry of Health for theoretical research on the Moskva River. Prof. S. SKADOWSKY directs the work of the station.— *Cf.* LENZ 1927.

Vladikavkas (Caucasus) : **North Caucasus Hydrobiological Station:** — Established in 1923 for theoretical hydrobiological investigation of alpine waters. — *Station publication:* Travaux de la Station Biologique du Cauc. du Nord (1925-). — *Cf.* LENZ 1927.

Vladivostok: **Pacific Institute of Fisheries and Oceanography:** — Near Ussuri Bay which is free from ice during the winter. Founded in 1925 under the direction of Prof. K. M. DERJUGIN and now sponsored by the All-Union Scientific Research Institution of Marine Fisheries and Oceanography for researches in the hydrology, hydrobiology, and ichthyology of the region. The plant contains a museum, aquarium, library, and several laboratories. — *Cf.* Int. Rev. Hydrobiol. 15:396-400; Fifth Pacific Science Congress 1:619-22; VAUGHAN 1934; VAUGHAN 1937.

— *UNION OF SOUTH AFRICA* —

Frankenwald: **Botanical Research Station of the University of Witwatersrand:** — *Cf.* Chronica Botanica 1939.

Sea Point: **Marine Biological Station of the Division of Fisheries:** — On the western side of the Cape Peninsula, with admirable opportunities for the study of marine flora and fauna. Established in 1939 by the Division of Fisheries of the Department of Commerce and Industry, being partially a continuation of the biological station founded in 1895 at St. James on False Bay. Dr. CECIL VON BONDE directs the work of the station, which has an annual budget of £13,000. The plant contains a library, darkroom, public aquarium, several laboratories, the 136-foot, 313-ton steam survey vessel, Africana, and a 50-foot motorboat, Impala. — *Station publications:* Annual Report of the Division of Fisheries; Investigation Reports. — *Cf.* VAUGHAN 1937.

— *UNITED STATES OF AMERICA* —

— *Arizona* —

Flagstaff: **San Francisco Mountain Zoological Station:** — At an altitude of 7,100 feet. Founded in 1926 by HAROLD S. COLTON and now sponsored by the Northern Arizona Society of Science and Art to form a center from which the biology, geology, ethnology, and archaeology of the Plateau of Northern Arizona may be studied. The station makes use of the facilities of the Museum of Northern Arizona. Open from June to September. — *Cf.* Science 69:132; Turtox 1932.

— *California* —

Angwin: **Pacific Union College Field Nature School:** — An itinerant field school, with headquarters at Pacific Union College. Prof. HAROLD W. CLARK directs the work of the school, which offers a course in field nature study every other summer. — *Cf.* Turtox 1937.

Corona Del Mar: **Kerckhoff Marine Laboratory:** — Sponsored by the California Institute of Technology for research in experimental embryology, physiology, marine ecology, biophysics, and chemistry to supplement that done at the sponsoring institution. Prof. G. E. MACGINITIE directs the work of the station, which is housed in a 2-story building. — *Cf.* VAUGHAN 1934; VAUGHAN 1937.

Dillon Beach: **Pacific Marine Laboratory:** — Founded in 1933 by the College of the Pacific for instruction and research in marine biology. Prof. ALDEN E. NOBLE directs the work of the station, which is open from June to September. Summer course work is given in general zoology and invertebrate zoology.

Laguna Beach (Orange County): **Laguna Beach Marine Laboratory:** — Founded in 1911 by Prof. C. F. BAKER and now sponsored by Pomona College for summer instruction in biology for undergraduate and graduate students. Prof. WILLIAM A. HILTON directs the work of the station, which is open during the summer months only. Summer course work is offered in the biology of vertebrates and invertebrates, human biology, human origins, and animal ecology. — *Cf.* Int. Rev. Hydrobiol. 7:134-35; Science 39:200-02; The Biologist 18:86-87; MAGRINI 1927; VAUGHAN 1934; VAUGHAN 1937; Turtox 1937.

La Jolla: **Scripps Institution of Oceanography:** — Within collecting range of the institution are long stretches of sandy shores interspersed with rocky reefs exposed to the open sea. Founded in 1892 by Dr. WILLIAM E. RITTER at Pacific Grove and moved to present site in 1905. Sponsored by the University of California for research and graduate instruction in oceanography and marine biology. Dr. HARALD U. SVERDRUP directs the work of the station, which has an annual budget of $110,000. The resident scientific staff consists of 12 persons. The equipment includes a public aquarium, 24 cottage residences, seismograph room, museum, offices, library, assembly room, many laboratories, a re-enforced concrete pier, and the 104-foot research vessel, E. W. Scripps. Course work is given in marine meteorology, physical oceanography, marine geology, chemical oceanography, marine microbiology, phytoplankton, marine invertebrates, marine biochemistry, and biology of fishes. — *Station publications:* Bulletin of the Scripps Institution of Oceanography of the University of California, Technical Series (1927-   ); annual reports on the activity of the institution appear in the Transactions, American Geophysical Union. — *Cf.* Harpers 110:456-63; Science 26:386-88; University of California Chronicle 9:1-7; Int. Rev. Hydrobiol. 1:863-65; University of California Publications in Zoology 9(4):137-248; Pop. Sci. Mon. 86:223-32;

School and Society 3:453-54; Science 63:297; Scientific Monthly 37:371-75; The Collecting Net 11(2):1-5; The Biologist 18:87-96; MAGRINI 1927; VAUGHAN 1934; Turtox 1937; VAUGHAN 1937.

Norden (Placer County): **San Francisco State College Science Field Session:** — Sponsored by San Francisco State College to provide opportunity for study in one of California's most attractive localities. Summer course work is given in astronomy, geology, and the flora and fauna of the Sierra. No research facilities.

Pacific Grove: **Hopkins Marine Station:** — In the Monterey Bay region, with extraordinarily rich fauna and flora. Founded in 1892 as the Hopkins Seaside Laboratory by DAVID STARR JORDAN, CHARLES HENRY GILBERT, and OLIVER PEEBLES JENKINS. Now sponsored by Stanford University to undertake research in biology, to provide facilities for visiting investigators, and to furnish elementary and advanced instruction in biology. Prof. WALTER K. FISHER directs the work of the station. The equipment includes a small museum, marine shop, library, offices, darkrooms, and many well-equipped laboratories. Summer courses are given in the ecology of marine organisms, marine biology, marine invertebrates, marine fishes, marine algae, general microbiology, comparative physiology, physiology of marine plants, and experimental embryology. — *Station publication:* Annual Bulletin of the Hopkins Marine Station. — *Cf.* Zoe 4:58-63; Natural Science 11:28-35; Overland Monthly n.s. 32:208; Jour. Applied Microscopy and Laboratory Methods 5:1869-75; Pop. Sci. Mon. 86:223-32; Science 47:410-12; Int. Rev. Hydrobiol. 10:547-49; Science 62:76; Scientific Monthly 29:298-303; The Collecting Net 6:65-71; The Biologist 18:96-99; SAND 1898; MAGRINI 1927; VAUGHAN 1934; Turtox 1937; VAUGHAN 1937.

San Jose: **West Coast School of Nature Study:** — Founded in 1931 and sponsored by San Jose State College to better prepare teachers for the "nature in the classroom" type of teaching. Prof. P. VICTOR PETERSON directs the work of the school, which is almost wholly in the field, and changes its site frequently. There are no research facilities. — *Cf.* Turtox 1937.

Santa Barbara: **Santa Barbara School of Natural Science:** — Sponsored by Santa Barbara State College in order to offer popular summer field courses in nature study for California teachers. No research facilities are available. — *Cf.* TURTOX 1937.

Yosemite National Park: **Yosemite School of Field Natural History:** — The fauna and flora of the area are extensive, due to the wide range of topography and elevation (2,000 to 13,000 feet). Founded in 1925 by Dr. HAROLD C. BRYANT and sponsored by the U. S. National Park Service to train students in methods of interpreting living nature and to train naturalists for the National Park Service. Mr. C. A. HARWELL directs the work of the school, which offers a 7-week course in natural history during the summer months. Research facilities are not available. — *Cf.* School and Society 32:590-92; Nature Magazine 19:274; Turtox 1937.

— *Colorado* —

Cuchara Camps: **Nature Enjoyment Camp:** — At an altitude of 8,200 feet in the Rocky Mountains. Founded in 1939 and sponsored by the Huerfano Group of the Colorado Mountain Club to train leadership in methods of out-of-door teaching and nature guiding. No research facilities are available.

Gothic (Gunnison County): **Rocky Mountain Biological Laboratory:** — In an area comprising about a half million acres of virgin territory, with elevations ranging from 8,000 to 14,000 feet. Founded in 1927 and sponsored by the Rocky Mountain Biological Laboratory, Inc., for research and instruction in subjects best studied in high mountain areas. Dr. JOHN C. JOHNSON directs the work of the station, which consists of 15 buildings and staff residences. Summer courses are given in ecology, field botany, parasitology, and other biological sciences and geology. The laboratory is open from June twentieth to September first. — *Cf.* The Biologist 18:105-08; Turtox 1937.

Mount Evans: **Mount Evans Laboratory:** — At the summit of Mount Evans, 14,250 feet above sea level. Founded in 1936 and now sponsored by the University of Denver and the Massachusetts Institute of Technology to study high altitude phenomena. Prof. J. C. STEARNS directs the work of the laboratory, which is equipped

with both scientific and living facilities. The laboratory is open from June to October. — *Cf.* Science 31:220; *Ibid.* 87:431-32; Scientific Monthly 46:242-48.

Nederland: **Science Lodge:** — On the flank of Mount Niwot, 9,500 feet above sea level, just below timberline and close to the continental divide. Sponsored by the University of Colorado for actual field experience in geology and biology. Summer courses are given in field biology and many phases of geology. The station is open from the third week of June to the fourth week of August. — *Cf.* Univ. Colorado Bull. 17(1):1-14; Science 56:162-63; The Biologist 18:101-04; Turtox 1937.

— Connecticut —

Lakeville: **Science of the Out-of-Doors:** — Established by Teachers College of Columbia University to give teachers guidance in the utilization of features in the natural phenomena of the out-of-doors. Prof. F. L. Fitzpatrick directs the work of this school, which offers a 4-week course in field work each summer. — *Cf.* The Biologist 18:109-10; Turtox 1937.

— Florida —

Belle Isle (Miami Beach): **Belle Isle Laboratory of the University of Miami:** — Located on an island on the auto causeway connecting the cities of Miami and Miami Beach. Within an area readily accessible to the laboratory is found a wide variety of aquatic habitats and the Gulf Stream is only a short distance from land. Established by the University of Miami with Dr. F. C. Walton Smith as director. Ample laboratory accommodations for classes and independent investigators are available and living facilities may be obtained nearby. — *Cf.* Science 98:141-43.

Englewood: **Bass Biological Laboratory:** — On Lemon Bay which opens into the Gulf of Mexico. Founded in 1932 by the late John F. Bass, jr. to furnish research facilities to investigators in biological fields where the fauna, flora, and climate play an important rôle in the problems under observation.

Pensacola: **Gulf Coast Fisheries Laboratory:** — Offshore the laboratory there are coral reefs and sand, mud, rock, and shell bottoms. Founded in 1937 and sponsored by the United States Fish and Wildlife Service for biological research on fisheries and related problems. Dr. A. E. Hopkins directs the work of the laboratory. The equipment includes a library, museum, dormitory, residences, boat house, several kinds of laboratories, and several boats. — *Cf.* Science 90:11; Proc. Fla. Acad. Sci. 4:175-78.

— Illinois —

Champaign: **University of Illinois Animal Ecology Study Trip:** — An itinerant field station sponsored by the Department of Zoology of the University of Illinois. Established in 1936 for instruction in animal ecology. Prof. V. E. Shelford directs the work of the study trip, which offers no facilities to investigators.

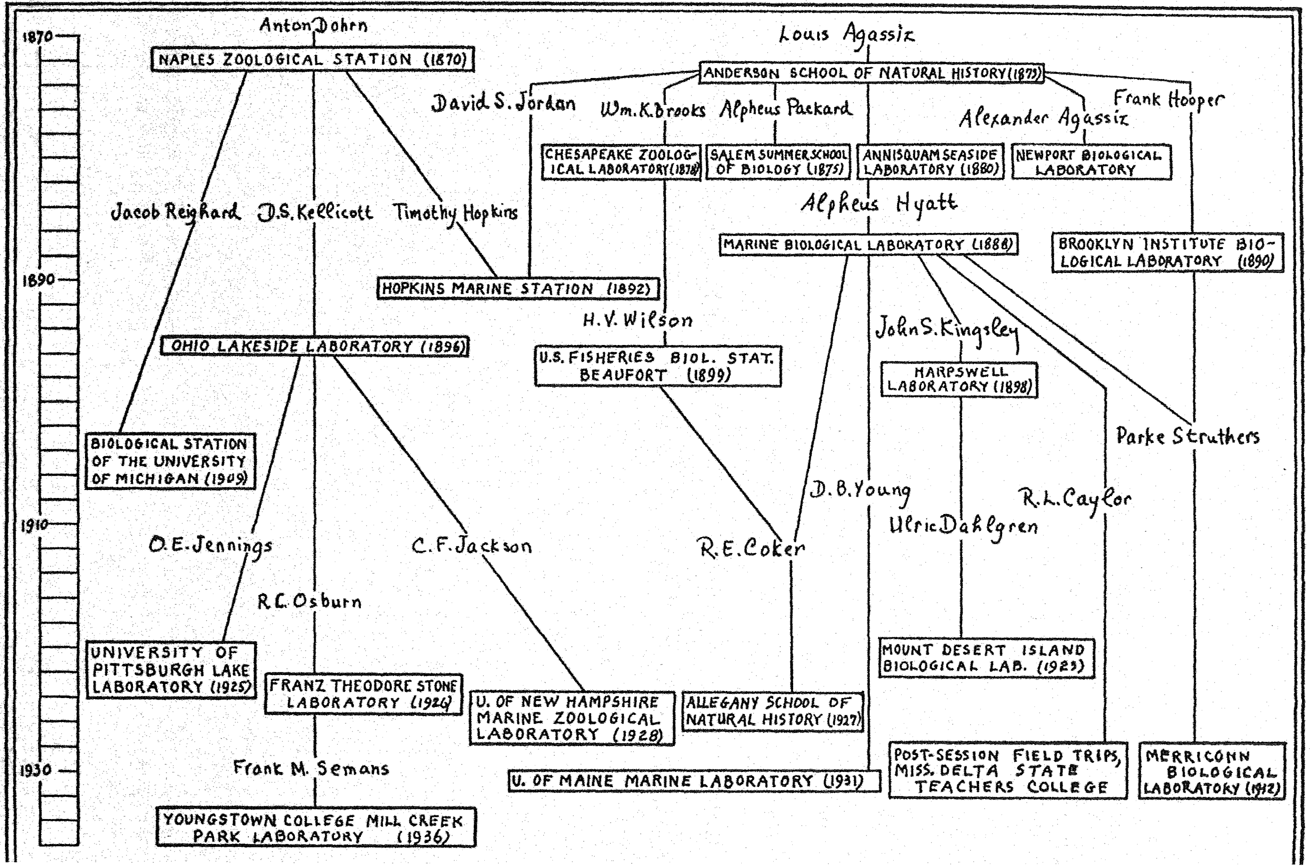
— Indiana —

Winona Lake: **Indiana University Biological Station:** — Habitats available for study include mesophytic deciduous forests, a variety of glacial lakes in various stages of development and decay, and a medium-sized river. Founded in 1895 by Dr. C. H. Eigenmann and now sponsored by Indiana University for research in most phases of fresh water biology and physics. Dr. William E. Ricker directs the work of the station, which is open during June, July, and August. — *Cf.* Science 10:925-29; Lenz 1927; Turtox 1937.

— Iowa —

McGregor: **American Institute of Nature Study:** — Founded in 1918 and now sponsored jointly by the Iowa Conservation Commission and the citizens of McGregor for instruction in nature study. Rev. Glenn W. McMichael is executive director of the institute, which gives a 2-week course in nature study each summer. — *Cf.* Turtox 1937.

Milford: **Iowa Lakeside Laboratory:** — On West Okoboji Lake, of glacial origin and 132 feet deep with a shoreline of 18 miles. Founded in 1909 and now sponsored by a board of managers from several state and federal agencies for the purpose of studying the hydrology and biology of the State of Iowa. Prof. Joseph H. Bodine is



1870
1890
1910
1930
Anton Dohrn
NAPLES ZOOLOGICAL STATION (1870)
Louis Agassiz
ANDERSON SCHOOL OF NATURAL HISTORY (1873)
David S. Jordan
Wm. K. Brooks
Alpheus Packard
Alexander Agassiz
Frank Hooper
CHESAPEAKE ZOOLOGICAL LABORATORY (1878)
SALEM SUMMER SCHOOL OF BIOLOGY (1875)
ANNISQUAM SEASIDE LABORATORY (1880)
NEWPORT BIOLOGICAL LABORATORY
Jacob Reighard
D. S. Kellicott
Timothy Hopkins
Alpheus Hyatt
MARINE BIOLOGICAL LABORATORY (1888)
BROOKLYN INSTITUTE BIOLOGICAL LABORATORY (1890)
HOPKINS MARINE STATION (1892)
H. V. Wilson
John S. Kingsley
OHIO LAKESIDE LABORATORY (1896)
U.S. FISHERIES BIOL. STAT. BEAUFORT (1899)
HARPSWELL LABORATORY (1898)
BIOLOGICAL STATION OF THE UNIVERSITY OF MICHIGAN (1909)
Parke Struthers
D. B. Young
R. L. Caylor
Ulric Dahlgren
O. E. Jennings
C. F. Jackson
R. E. Coker
R. C. Osburn
MOUNT DESERT ISLAND BIOLOGICAL LAB. (1923)
UNIVERSITY OF PITTSBURGH LAKE LABORATORY (1925)
FRANZ THEODORE STONE LABORATORY (1926)
U. OF NEW HAMPSHIRE MARINE ZOOLOGICAL LABORATORY (1928)
ALLEGANY SCHOOL OF NATURAL HISTORY (1927)
POST-SESSION FIELD TRIPS, MISS. DELTA STATE TEACHERS COLLEGE
MERRICONN BIOLOGICAL LABORATORY (1932)
Frank M. Semans
U. OF MAINE MARINE LABORATORY (1931)
YOUNGSTOWN COLLEGE MILL CREEK PARK LABORATORY (1936)

director of the laboratory. Research, instructional, and living accommodations are available. Summer courses are given in biology and protozoology. The station is open between the second week in June and the third week in August. — *Cf.* Science 49:466-67; The Biologist 18:114-22; LENZ 1927; Turtox 1937.

— *Louisiana* —

Grand Isle: **Louisiana State University Field Laboratory:** — On an island at the foot of Barataria Bay, west of the mouth of the Mississippi River, with a fine sand beach on the Gulf of Mexico and mud flats and marshes on Barataria Bay. Sponsored by Louisiana State University for instruction and research on Louisiana marine life. Prof. E. H. BEHRE is director of the laboratory, which consists of one building and a tent colony for living accommodations. Summer course work is given in marine zoology for advanced students and biology teachers. The laboratory is open during June and July. — *Cf.* Turtox 1937.

— *Maine* —

Damariscotta: **Audubon Nature Camp:** — Established by the National Audubon Society to offer adult leaders at low cost two-week sessions of ecological study guided by a highly competent and enthusiastic staff of specialists. Mr. CARL W. BUCHHEISTER directs the work of the camp which has an annual budget of $13,000. Facilities are not available to research investigators. — *Cf.* Bird Lore 37:440-41; *Ibid.* 38:3, 36-37, 204-06, 288-92, 348-52; *Ibid.* 39:127-32, 366; Natural History 39:318-28; Nature Magazine 31:212-14; Bird Lore 40:120-22; Turtox 1937.

Lamoine: **University of Maine Marine Laboratory:** — Easy access to the unusually rich flora and fauna of the Gulf of Maine. Sponsored by the University of Maine to offer instruction in marine zoology. Prof. JOSEPH M. MURRAY is director of the laboratory, which is open from July first to September first. There are ample research, instructional, and living accommodations. Course-work is given each summer in marine invertebrate zoology. — *Cf.* Science 87:505; Turtox 1937; VAUGHAN 1937.

Salisbury Cove: **Mount Desert Island Biological Laboratory:** — Accessible to the Acadian fauna, with tides of eleven to fourteen feet. Founded in 1898 as the Harpswell Laboratory by J. S. KINGSLEY and now sponsored by the Mount Desert Island Biological Laboratory, Inc., to establish and maintain a laboratory for biological study and investigation in the State of Maine. Prof. WILLIAM H. COLE is director of the laboratory, which has an annual budget of $8,000. Equipment includes dining hall, darkroom, library, shop, laboratories, and the 30-foot power boat, Dahlgren. Course work is given each summer in invertebrate zoology. The laboratory is open from June fifteenth to September fifteenth. — *Station publication:* Bulletin of the Mount Desert Island Biological Laboratory. — *Cf.* Science 17:983-86; Popular Science Monthly 74:504-13; Int. Rev. Hydrobiol. 4:537-39; Science 41:603-04; Natural History 22:47-55; The Biologist 18:123-26; Science 87:13; *Ibid.* 92:305; Turtox 1937; VAUGHAN 1937.

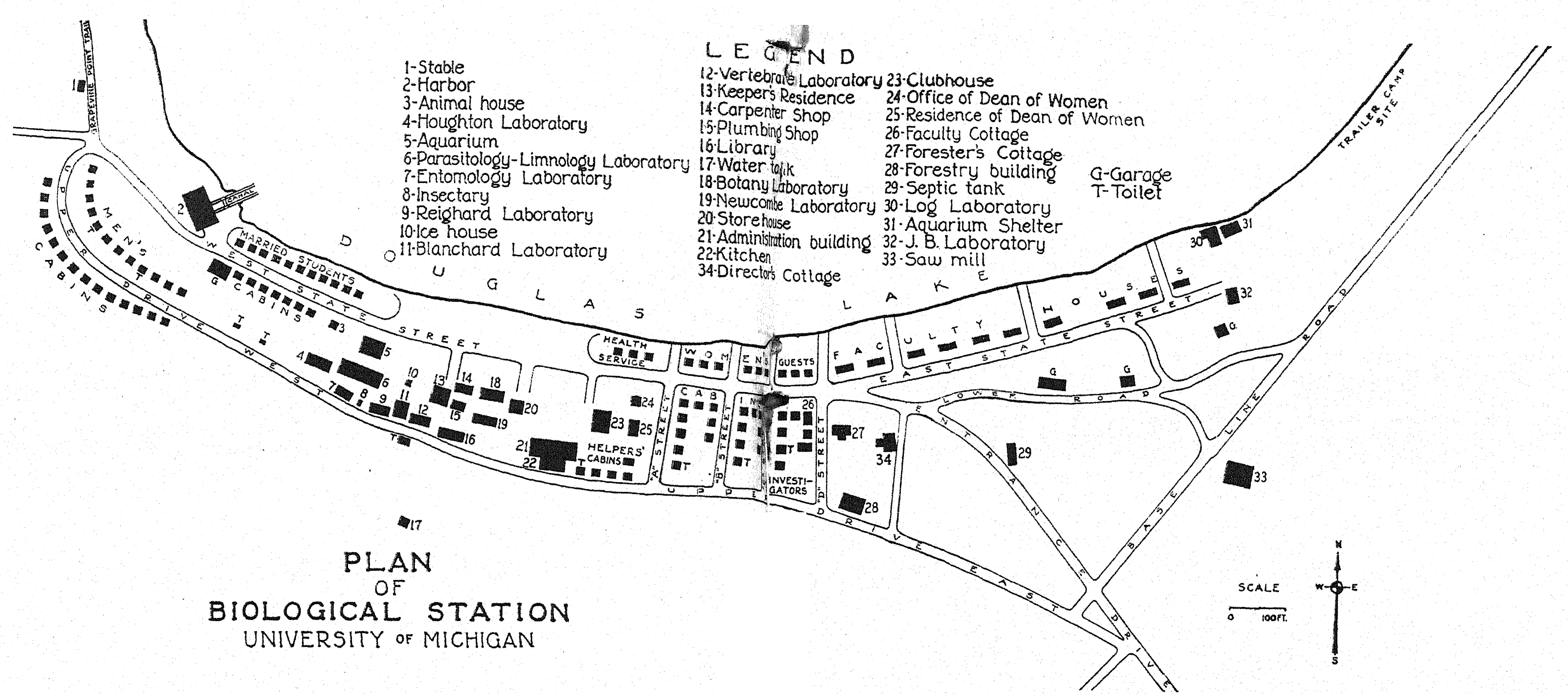
— *Maryland* —

Solomons Island: **Chesapeake Biological Laboratory:** — On the western shore of Chesapeake Bay at the mouth of the Patuxent River. Maintained by the State of Maryland as a research and study center where facts tending toward a fuller appreciation of nature may be gathered and disseminated. Prof. R. V. TRUITT is director of the laboratory, which has an annual budget of $21,000. The two, 3-story brick buildings contain offices, museum, classrooms, library, living accommodations, and many well-equipped laboratories. Several types of boats are available. Summer courses are given in economic zoology, invertebrates, invertebrate embryology, and diatoms. — *Station publications:* Bulletin of the Chesapeake Biological Laboratory; Annual Report. — *Cf.* Science 76:205-06. *Ibid.* 85:513-14; The Biologist 18:127-34; Turtox 1937; VAUGHAN 1937.

— *Massachusetts* —

Plymouth: **Nature Guide School:** — Sponsored by Massachusetts State College to train outdoor leaders. Prof. WILLIAM G. VINAL is director and founder of the school, which offers a 6-week summer course in nature education. — *Cf.* Turtox 1937.

Woods Hole: **Marine Biological Laboratory:** — The fauna and flora are exceptionally rich, there being no muddy river or city sewage to pollute the sea water and



A PLAN OF THE GROUNDS AND BUILDINGS OF THE BIOLOGICAL STATION OF THE UNIVERSITY OF MICHIGAN AT CHEBOYGAN LAKE, MICHIGAN (*courtesy Univ. of Michigan*).

the shore being varied by necks, points, flats, gutters, bays, and islands. Founded in 1888 as an outgrowth of the Annisquam Seaside Laboratory with Dr. C. O. WHITMAN as director. It is now an autonomous institution dedicated to the promotion of biological research by supplying investigators with facilities for their work and by offering courses which contribute to the training of investigators. Prof. CHARLES PACKARD is director of the laboratory, which maintains a summer staff of 44 professors. The plant includes a 4-story brick laboratory building, four wooden laboratory buildings, three buildings used by the supply department, carpenter shop, mess hall, club house, dwellings, and dormitories. These contain offices, dark rooms, balance rooms, X-ray rooms, auditorium, museum, many private and general laboratories, and a library, the latter containing 52,000 bound volumes, 130,000 reprints, and 1,300 current scientific periodicals. Summer courses are given in protozoology, invertebrate zoology, embryology, physiology, and the morphology and taxonomy of algae. — *Station publications:* Biological Bulletin (1899-); Annual Report. — *Cf.* Science 9:382-83; *Ibid.* 11:20-21, 305-06; *Ibid.* 12:37-38; Pop. Sci. Mon. 42:459-71; Science 7:37-44; *Ibid.* 12:233-44; *Ibid.* 16:529-33, 591-92; Smithsonian Report for 1902:625-32; Science 26:839-42; *Ibid.* 28:509-10; School Science and Mathematics 8:337-40; Nature 84:527-28; Int. Rev. Hydrobiol. 5:583-89; Hearst's Magazine 24:784-86; Outlook 107:767-68; Pop. Sci. Mon. 85:203-04; Science 40:229-32; *Ibid.* 58:142-43, 198; New Republic 36:178-79; Science 59:371-72; *Ibid.* 62:26, 271-80; School and Society 26:592-93; Scientific Monthly 27:186-90; Science 70:208-10; *Ibid.* 80:308; Scientific Monthly 39:377-80; The Biologist 18:135-39; Science 88:402; *Ibid.* 89:57-58; Turtox News 18:93-94; Science 92:213; *Ibid.* 94:206; *Ibid.* 95:14; SAND 1898; Turtox 1937; FRANK R. LILLIE: The Woods Hole Marine Biological Laboratory. University of Chicago Press, 284 pp., 1944.

Woods Hole: **Woods Hole Oceanographic Institution:** — The nearness of Woods Hole to the transition zone between inshore and oceanic waters, the abruptness of this transition, and the nearness to the continental abyss and ocean basin all make this a particularly favorable headquarters for investigations into many of the basic problems in oceanography that are now engaging scientific attention. Founded in 1930 by an endowment from the Rockefeller Foundation on recommendation of the National Academy of Sciences. It is now an autonomous institution dedicated to the study of oceanography in all its branches. Prof. COLUMBUS ISELIN directs the work of the station, which has an annual budget of $110,000. The 4-story building contains a constant temperature room, machine shop, offices, chart room, library, drafting room, darkrooms, and many well-equipped general and individual laboratories. Boats include the 142-foot research ship, Atlantis, and the 40-foot gasoline launch, Asterias. No instruction is offered, but a limited number of visiting investigators may be accommodated, either at the institution or on the Atlantis. — *Station publications:* Papers in Physical Oceanography and Meteorology (1933-); Collected Reprints (1933-); Report for the Year. — *Cf.* Jour. Conseil Int. Explor. Mer 5:226-28; VAUGHAN 1937; FRANK R. LILLIE, The Woods Hole Marine Biological Laboratory. University of Chicago Press, pp. 177-91, 1944.

— *Michigan* —

Clear Lake (Montmorency County): **Michigan State College School of Field Biology:** — Sponsored by Michigan State College to train teachers, undergraduates, and graduate students in biology. Prof. JOSEPH W. STACK directs the work of the school. — *Cf.* Turtox News 18(2):40-42; Turtox 1937.

Cheboygan: **Biological Station of the University of Michigan:** — On the shores of Douglas Lake, in the transition zone between the evergreen coniferous forest region to the north and the deciduous hardwood forest region to the south. Founded in 1909 and now sponsored by the University of Michigan for teaching and research in botany and zoology. Prof. ALFRED H. STOCKARD is director of the station, which has an

annual budget of $16,500. The faculty consists of eleven professors. There is a well-equipped campus with excellent laboratory and living facilities. Each summer courses are given in the taxonomy of fresh-water algae, taxonomy of the bryophytes, systematic botany, plant anatomy, plant ecology, aquatic flowering plants, plant tissue culture and morphogenesis, entomology, ornithology, ichthyology, natural history of invertebrates, herpetology and mammalogy, limnology, and helminthology. The station is open from June twentieth to September first. — *Cf.* School Science and Mathematics 13:411-15; Science 47:381-83; *Ibid.* 49:466-67; Report of the Michigan Academy of Science, Arts and Letters 22:91-99; Science 57:412-13; The Collecting Net 6:169-73; The Biologist 13:130-37; *Ibid.* 18:140-48; LENZ 1927; Turtox 1937.

— Minnesota —

Itasca State Park: **Lake Itasca Forestry and Biological Station:** — On the east shore of Lake Itasca, with a diverse series of habitats furnishing a characteristic succession of plants and animals. Sponsored by the University of Minnesota for the advancement of terrestrial and fresh-water biology by means of promoting and providing opportunities for instruction and research. Prof. T. SCHANZ-HANSEN directs the work of the station. There are ample laboratory and living accommodations. Summer courses are given in field taxonomy (botany), field botany, elementary field ecology, bryophytes and pteridophytes, field research methods in ecology, field dendrology, field mycology, field entomology, wildlife conservation, parasitology, natural history of invertebrates and fishes, protozoology, limnology, and helminthology. The station is open from June to October.

— Mississippi —

Biloxi: **Mississippi Delta State Teachers College Field Botany Trip:** — Sponsored by Mississippi Delta State Teachers College to give instruction in field botany. Prof. R. L. CAYLOR directs the work of the trip, which is housed in a permanent camp on the shore of the Gulf of Mexico. A summer course in field botany is given. — *Cf.* Turtox 1937.

— New Hampshire —

Isles of Shoals: **Isles of Shoals Marine Zoological Laboratory:**—An excellent base for the study of marine life under a variety of conditions. Established in 1928 by Prof. C. FLOYD JACKSON and now directed by him for the University of New Hampshire. There are ample laboratory and living accommodations on the island. Summer courses are given in comparative anatomy, invertebrate zoology, histology-embryology, marine biology, laboratory technique, and the teaching of biology in secondary schools. The laboratory is open only during the summer months. — *Cf.* The Biologist 18:153-59; Turtox 1937; VAUGHAN 1937.

Nelson: **Merriconn Biological Laboratory:** — Founded in 1933 by Prof. PARKE H. STRUTHERS and now maintained by him as a private laboratory open to teachers and advanced students who wish to devote a part of the summer to increase their professional background and investigations in the field of biology. Laboratory and living accommodations are available. Summer courses are given in comparative anatomy, field zoology, and nature training. The laboratory is open to independent investigators from June fifteenth to September fifteenth. — *Cf.* The Biologist 18:111-13; Turtox 1937.

North Woodstock: **New Hampshire Nature Camp:** — In a high mountain valley about 1,800 feet above sea level. An autonomous institution under the sponsorship of Mr. LAWRENCE J. WEBSTER to train teachers and others in nature study and in various methods of imparting this knowledge to others. Dr. JARVIS B. HADLEY directs the work of the camp, which offers limited facilities to investigators. — *Cf.* Turtox 1937.

— New Mexico —

Las Vegas: **Biology Field Courses of Texas Technological College:** — At an altitude of 8,000 feet in a heavily timbered valley surrounded by rather high mountains and mesas. Founded in 1934 and sponsored by Texas Technological College to teach undergraduates biology. Dr. R. A. STUDHALTER is director of the station. Summer course work is given in general biology, although there are no facilities for investigators. — *Cf.* Turtox 1937.

— *New York* —

Cold Spring Harbor (Long Island): **Biological Laboratory of the Long Island Biological Association:** — The harbor is not exposed to the surf of Long Island Sound, the result being that marine animals and plants grow near the laboratory in great numbers. Founded in 1890 by Prof. FRANKLIN W. HOOPER with Dr. BASHFORD DEAN as director. The laboratory is now sponsored by an autonomous institution, the Long Island Biological Association, with an annual budget of about $25,000. Dr. M. DEMEREC is director of the laboratory. The equipment includes technical shops, library, animal rooms, many kinds of laboratories, dining room, and dormitories. Summer courses were given in experimental surgery, experimental endocrinology, and marine and fresh water zoology. Each summer the laboratory invites a group of chemists, mathematicians, physicists, and biologists to take part in a 5-week symposium in some selected aspect of quantitative biology. The laboratory closely cooperates with the adjacent Dept. of Genetics of the Carnegie Institution. — *Station publications:* Cold Spring Harbor Symposia on Quantitative Biology (1933-); Annual Report. — *Cf.* Int. Rev. Hydrobiol. 4:223-26; Science 59:332; *Ibid.* 63:419; Rivista di Biologia 12:150-58; Science 88: suppl. 10; The Collecting Net 15(1):1, 3-4; SAND 1898; Turtox 1937; Science 99:395-397.

[*Quaker Bridge:* **Allegany School of Natural History:**—After a short but influential existence, this institution was abandoned permanently in 1941. — *Cf.* Science 65:201; Playground 21:170; School and Society 27:598-601; *Ibid.* 28:106; *Ibid.* 31:197-98; Elementary School Journal 29:569-70; Bird Lore 35:125-28; School Science and Mathematics 38:67-71.]

— *North Carolina* —

Beaufort: **Duke University Marine Station:** — Established by Duke University to study marine biology. Prof. A. S. PEARSE is director. There are three dormitories, a laboratory-building, a boat-house, a dining hall, and the caretaker's residence. Summer courses are given in algae, marine zoology, plant ecology, parasitology, and invertebrate zoology. — *Cf.* Science 87:454.

Beaufort: **Fisheries Biological Station at Beaufort, North Carolina:** — Easily accessible are a large variety of aquatic animals and plants, including those living in the open ocean, in brackish water, and in fresh water. Established in 1899 and now sponsored by the United States Fish and Wildlife Service for investigations of marine biology. Dr. HERBERT F. PRYTHERCH is director of the station, which has an annual budget of about $17,000. The eight buildings contain a marine aquarium, museum, dormitory rooms, library, and several types of laboratories. Available boats include a 46-foot cruiser, a 33-foot boat, and an 18-foot outboard motorboat. — *Cf.* Int. Rev. Hydrobiol. 7:122-26; Science 69:547-49; U. S. Bureau of Fisheries Economic Circular 72; MAGRINI 1927; Turtox 1937; VAUGHAN 1937.

Highlands: **Highlands Museum and Biological Laboratory:** — Situated abreast of the Blue Ridge at an elevation of 4,000 feet. Established in 1927 and now an autonomous institution to promote, conduct, and maintain biological research in the southern Appalachian Mountains. Prof. W. C. COKER directs the work of the laboratory, which is open during July and August to investigators. — *Station publication:* Publications of the Highlands Museum and Biological Laboratory (1930-). — *Cf.* Jour. Elisha Mitchell Scientific Society 49:35; Mycologia 25:330-31.

— *Ohio* —

Put-in-Bay: **Franz Theodore Stone Laboratory:** — On an island in Lake Erie. Established at Sandusky in 1896 and moved to present site in 1918. Sponsored by Ohio State University in coöperation with the Ohio Division of Conservation and Natural Resources for the development of biological research and the application of its results to the welfare of humanity. Prof. THOMAS H. LANGLOIS directs the work of the station, which maintains a year-round scientific staff of seven persons. There is a well-equipped, 3-story laboratory building and also living accommodations. Summer courses are given in plant taxonomy, plant ecology, fresh water algae, higher aquatic plants, physiology of aquatic plants, advanced entomology, aquatic entomology, climatology, invertebrate zoology, aquiculture, ichthyology, animal parasitology, field

biology, advanced ornithology, herpetology, comparative physiology, and physiology of fishes. — *Station publication:* Contributions from the Franz Theodore Stone Laboratory.— *Cf.* Jour. Applied Micro. 6:2550-553; Science 49:466-69; The Biologist 18:149-52; Science 87:315-16; Turtox 1937.

— *Oregon* —

Coos Head: **Oregon Institute of Marine Biology:** — At the entrance to Coos Bay which contains wide stretches of tide-flats interspersed with sandy and rocky beaches. Sponsored by the Oregon State System of Higher Education for instruction and research in marine biology. Prof. EARL L. PACKARD is director. Summer course work is given in field zoology, biology of fishes, embryology of marine invertebrates, invertebrate zoology, taxonomy and ecology of marine algae, morphology of marine algae, systematic botany, paleobiology, and biological science survey. The Institute is open during June and July. — *Cf.* Science 85:240; VAUGHAN 1934; VAUGHAN 1937.

— *Pennsylvania* —

Bristol Township (Bucks County): **Effingham B. Morris Biological Farm:** — Sponsored by the Wistar Institute of Anatomy and Biology with Dr. EDMOND J. FARRIS as executive director. Laboratory and living accommodations are available to qualified investigators. — *Cf.* Bull. Wistar Institute of Anatomy and Biology 8:1-31.

Huntingdon County: **Pennsylvania State College Nature Camp:** — Founded in 1923 by Prof. GEORGE R. GREEN and now sponsored by Pennsylvania State College to provide outdoor training and experience under expert field naturalists and to satisfy the demands of teachers and nature lovers for practical nature study and science field work. Ample living and laboratory facilities are available for summer course and research work in nature education. — *Cf.* Turtox 1937.

Presque Isle Peninsula (Erie County): **University of Pittsburgh Lake Laboratory:** — A peninsula in Lake Erie, with a continuous ecological series of ponds and marshes. Sponsored by the University of Pittsburgh as a field station for research and undergraduate instruction. Prof. O. E. JENNINGS is director of the laboratory, which is housed in a small, wooden building. Summer courses are given in field botany, nature study, field zoology, and entomology. The laboratory is open to investigators from the last week of June to the end of August. — *Cf.* Turtox 1937.

— *Rhode Island* —

Narragansett: **Narragansett Laboratory of Rhode Island State College:** — On the shore of Narragansett Bay, in which the winter fauna is predominately boreal and the summer fauna is Virginian with a periodic influx of open ocean and gulf stream forms in late summer. Sponsored by the Rhode Island Division of Fish and Game and Rhode Island State College to offer facilities for marine research. CHARLES J. FISH directs the work of the laboratory, which contains good scientific equipment. The laboratory is open from June fifteenth to September first to investigators. — *Cf.* VAUGHAN 1937.

— *South Dakota* —

Nemo: **South Dakota State College Botany Summer Camp:** — In the heart of the Black Hills with a diversity of biological habitats. Sponsored by the Botany Department of South Dakota State College for instruction and research in the taxonomy and ecology of the Black Hills flora. Prof. LEON C. SNYDER is director of the Camp, which is erected on land belonging to the National Forest Service. A summer course is given in the taxonomy of the Black Hills flora. Investigators may work at the camp between the second week of June and the third week of July.

Waubay: **Lake Enemy Swim Biological Station:** — Sponsored by Northern State Teachers College to offer the best possible opportunity to teachers, students, and investigators for the study and investigation of problems of the life sciences. Prof. SIDNEY R. LIPSCOMB directs the work of the station, which contains dormitories, dining hall, and a central laboratory building. Summer courses are given in natural science, animal biology, taxonomy of the flowering plants, plant anatomy, eugenics, and animal histology. No facilities are available to investigators. — *Cf.* Turtox 1937.

— Tennessee —

Reelfoot Lake: **Reelfoot Lake Biological Station:** — On the banks of Reelfoot Lake which was formed by an earthquake in 1815 and with the areas, therefore, definitely dated. Sponsored by the Tennessee Academy of Science to furnish opportunity for research to advanced investigators. Prof. Clinton L. Baker is director of the station, which consists of a well-equipped laboratory building. The station is open to investigators from June first to September fifteenth. — *Station publication:* Report of the Reelfoot Lake Biological Station (1937-). — *Cf.* Jour. Tenn. Acad. Sci. 1:11-15; Science 76:208; Turtox 1937.

— Utah —

Utah Lake: **Brigham Young University Lakeside Biological Laboratory:** — On a shallow, fresh-water lake with an area of about 75,000 acres. Sponsored by Brigham Young University to study the ecology of the flora and fauna of the lake. Prof. Vasco M. Tanner directs the work of the laboratory, which consists of one laboratory building. — *Cf.* Turtox 1937.

— Vermont —

Newfane: **Summer School of Bryology:** — The hills of southern Vermont offer a moss and hepatic flora which is unusually abundant. Sponsored by the Long Island Biological Association to instruct students wishing to gain proficiency in the study of mosses. Prof. A. J. Grout directs the work of the school, which contains a library, laboratory space, and a herbarium of 30,000 specimens. Summer course work of an informal nature is offered in bryology. The school is open to investigators from June to October. — *Station publication:* The Moss Flora of North America, North of Mexico.

Randolph: **Green Mountain Nature Camp:** — An autonomous institution directed by M. Elsie Osgood to combine an invigorating, but restful vacation in the open with a chance to study nature first-hand. Informal course work is given during the summer in nature study. Research facilities are not available.

— Virginia —

Chester: **Virginia Natural History Institute Nature Leaders Training Course:** — Founded in 1940 under the initiative of the National Recreation Association to provide training and practical field experience to leaders and prospective leaders for park, recreational, and camping agencies and educational institutions. Reynold E. Carlson is director of the Course, which is given during the summer. Research facilities are not available.

Mountain Lake: **Mountain Lake Biological Station:** — At an altitude of almost 4,000 feet, and within a radius of five miles collections can be made from places with a difference of 2,500 feet in altitude. Founded in 1929 and now sponsored by the University of Virginia to offer facilities for graduate instruction and research in the biological field to qualified students, teachers, and investigators from the Southern States. Prof. Ivey F. Lewis is director of the station, which has an annual budget of $11,000. Equipment includes a library, herbarium, museum, auditorium, darkrooms, culture rooms, offices, classrooms, dining hall, living cottages, dormitories, and trucks. Summer courses are given in the morphology of seed plants, plant taxonomy, phycology, mycology, protozoology, cell morphology, experimental morphogenesis, and hydrobiology. The station is open to investigators from June fifteenth to September first.— Cf. Science 80:112-13; Life 9:49-51; Turtox 1937.

Yorktown: **Virginia Fisheries Laboratory:** — Within easy reach of the James River and only seven miles from the deeper waters of Chesapeake Bay. Established recently by the College of William and Mary and the Commission of Fisheries in Virginia in order to conduct investigations and give instruction in aquatic biology and conservation. Dr. Curtis L. Newcombe is director of the laboratory. While classwork is done mainly at Williamsburg, research requiring running sea-water is conducted at Yorktown. The 45-foot Agnes Hope is used for off-shore studies.

— Washington —

College Place: **Walla Walla College Field Nature School:** — Sponsored by Walla Walla College to afford an opportunty for students interested in nature to learn to

understand nature from first-hand observation. An itinerant school, pupils travelling every other summer 800 miles from the Blue Mountains in eastern Oregon down the Columbia River to Mount Rainier. Prof. HAROLD W. CLARK is director of the school, which does not offer research facilities.

Friday Harbor: **University of Washington Oceanographic Laboratories:** — The inland waters of the San Juan Archipelago and adjacent territory have a great variety and wealth of marine flora and fauna. Founded in 1904 and now sponsored by the University of Washington for independent research, directed research, and seminar and formal courses in the different phases of oceanography. Prof. THOMAS G. THOMPSON is director of the laboratories, which have an annual budget of $15,000. The equipment includes seven laboratory buildings, stockroom, dining hall, living tents, cantilever pier, 50-foot power boat, Medea, and the 75-foot research vessel, Catalyst. There is also a 3-story laboratory building at Seattle. Summer courses are given in the physiology of bacteria, marine plants, physiology of marine plants, phytoplankton, oceanographic chemistry, physical oceanography, biochemistry of marine life, oceanographic meteorology advanced invertebrate embryology, and advanced invertebrate zoology. Research facilities are available during June, July, and August. — *Station publications:* University of Washington Publications in Oceanography (1932-); University of Washington Publications in Oceanography, Supplementary Series (1931-). — *Cf.* Pop. Sci. Mon. 86:223-32; Science 69:331-32; Natural History 36:73-80; Jour. Chemical Education 13:203-09; The Biologist 18:160-70; MAGRINI 1927; VAUGHAN 1934; Turtox 1937; VAUGHAN 1937.

Seattle: **University of Washington Field Course in Botany:** — An itinerant station sponsored by the University of Washington to acquaint students with the vegetation of North America and to give University of Washington botanists better access to the less well-known botanical regions of that area. Dr. C. LEO HITCHCOCK directs the work of this field course, which offers formal work in plant taxonomy during the summer. Independent investigators may accompany the course.

— *West Virginia* —

Morgantown: **West Virginia University Biological Expedition:** — An itinerant station sponsored by West Virginia University to complement the ordinary biological courses with outdoor laboratory work. Prof. P. D. STRAUSBAUGH directs the work of the expedition, which offers summer courses in botany and zoology. A limited number of investigators may be accommodated. — *Cf.* the Biologist 18:171-76; Turtox 1937.

Oglebay Park: **Oglebay Institute Nature Leaders Training School:** — Sponsored jointly by Oglebay Institute, Wheeling Park Commission, and West Virginia University for practical instruction in the field for nature teachers and others. Mr. A. B. BROOKS directs the work of this school, which offers a series of summer courses in natural history. Research facilities are not available.

— *Wisconsin* —

Long Lake: **Lost Lake Conservation Camp:** — Sponsored by the nine State Teachers Colleges of Wisconsin and the U. S. Forest Service to give teachers and prospective teachers an opportunity to gain a practical knowledge of conservation and an extensive biological background which is essential for this. Prof. THORPE LANGLEY directs the work of the camp, which makes use of former C.C.C. lodges. Summer courses are given in field zoology, field botany, nature study, and conservation. Research facilities are not available.

Trout Lake: **Trout Lake Limnological Laboratory:** — Several hundred lakes are found within a radius of 25 miles from the laboratory. Sponsored by the University of Wisconsin and the Wisconsin Conservation Department to study the physics, chemistry, and biology of Wisconsin lakes. Prof. CHANCEY JUDAY is director of the laboratory, which has an annual budget of $15,000. There are ample living and laboratory facilities. No course work is given, but independent investigators may work at the laboratory from June through September. — *Cf.* Trans. Wis. Acad. Sci., Arts, and Letters 25:337-52; The Biologist 18:177-82; Turtox 1937.

Williams Bay: **Geneva Lake Summer School of Natural Science:** — An autonomous

institution dedicated to correlate theory and practice by giving students an opportunity for personal observation of the geological formations, plants, and animals of southern Wisconsin. Dr. ARTHUR D. HASLER is director of the School, which has good living and field laboratory facilities. Summer courses are given in plant ecology, advanced plant taxonomy, glacial geology, field geology, field zoology, limnology, survey of astronomy, and the teaching of science. Research facilities are available during the summer months.—*Cf.* Turtox 1937.

— *Wyoming* —

Centennial: **University of Wyoming Science Summer Camp:**—In the subalpine zone of the Medicine Bow National Forest at an altitude of 9,500 feet. Founded in 1923 and now sponsored by the University of Wyoming for field instruction and research in botany, geology, and zoology. Prof. S. H. KNIGHT is director of the camp. The equipment includes a central log lodge, four laboratory buildings, and forty lodging cabins. Summer courses are given in fresh-water algae, taxonomy of vascular plants, ecology, field and laboratory general botany, Wyoming birds, aquatic zoology, elementary field and laboratory zoology, elementary field course in geology, and advanced field geology. The camp is open to investigators from June fifteenth to August first.—*Cf.* The Biologist 18:183-89; Turtox 1937.

Jackson: **Rocky Mountain Biological Station of the University of Michigan:**—In a rugged mountain area, near the continental watershed. Sponsored by the University of Michigan Summer Session to conduct a general plant survey of the region and explore the possibilities of the region for biological study and research. Prof. LEWIS E. WEHMEYER is director of the station, which makes use of the summer engineering camp of the University of Michigan. No formal courses are given, but research may be undertaken during July and August.

— *VENEZUELA* —

Rancho Grande (Maracay): **Biological Station of the New York Zoological Society:**—This has recently been established. Dr. WILLIAM BEEBE writes (May 29, 1945): "As to the permanence of my Rancho Grande, I am only able to say that it looks as if it might be continued. I shall spend ten months next year here, and both the Venezuelan Government and the Creole People as well as our Zoological Society are anxious to have it kept up. I hope to get some of the native scientists trained to carry it on. I should say there is a very fair chance of its being carried on."

— *YUGOSLAVIA* —

Rab: **Biological Station of the Czechoslovak Society for a Marine Biological Station:**—Sponsored by the Czechoslovak Society for a Marine Biological Station to enable Czechoslovakian biologists to work in sea biology. There is one building which contains laboratory facilities.—*Station publication:* Travaux (1933-).—*Cf.* VAUGHAN 1937.

Split: **Oceanografski Institut:**—Sponsored by the Government of Yugoslavia for researches in oceanography and biology and instruction for students. Prof. A. ERCEGOVIĆ directs the work of the institute. Equipment includes a public aquarium, library, living accommodations, and 25 laboratories. Courses are given in marine biology.—*Station publications:* Acta Adriatica; Annual Report.—*Cf.* VAUGHAN 1937.

Struga: **Die Hydrobiologische Abteilung der Antimalariastation zu Struga:**—*Cf.* LENZ 1927.

Crna Mlaka (Zdenčina, Kroatien): **Teichwirtschaftliche Versuchsstation:**—*Cf.* LENZ 1927.

After this booklet had been completed I received word of the publication of an extensive biography of ANTON DOHRN *by* THEODOR HEUSS (Berlin und Zürich: Atlantis-Verlag, pp. 319, 1940).—This is a very fine volume, of great interest to all interested in the development and methods of organization of biological stations.


STB

Chronica Botanica

Agronomia — Biologia — Genetica

Chronica Botanica

An International Collection of Studies in THE METHOD and HISTORY of BIOLOGY and AGRICULTURE

edited by FRANS VERDOORN, PH. D.

Managing Editor of 'A New Series of Plant Science Books' and 'Annales Cryptogamici et Phytopathologici'; Assoc. Editor, 'Natuurwet. Tijdschr. voor Ned.-Indië', 'Rec. Trav. Bot. Néerl.', 'Farlowia', 'Bryologist'; Bibliographer, Arnold Arboretum of Harvard University; Botan. Adviser, Board for the Netherlands Indies; Hon. Sec., Bot. Section of the Int. Union of Biological Sciences; Hon. Sec., Committee for Hepaticae of the Int. Nomenclature Commission; etc.

A link between plant scientists in all branches and in all countries

Volume 9 — 1945

WALTHAM, MASS., U.S.A.

Published by the Chronica Botanica Company

Phytopathologia – Silvicultura – Horticultura

MEMORIAE VIRI ILLUSTRISSIMI

MELCHIORIS TREUBII

GLORIOSI NOMINIS DIGNI HEREDIS

HIC CHRONICORUM BOTANICORUM

TOMUS NONUS

PIO GRATOQUE ANIMO

DEDICATUR

PRIMUS VIR BOGORI NECNON TJIBODAE

INVESTIGATORIBUS EXTRANEIS LOCUM

AD

BIOLOGIAM TROPICAM INQUIRENDAM FECIT

OPUSQUE TREUBIANUM IN POSTERUM PERMANEBIT

EXEMPLUM

INVESTIGATORIBUS DIRECTORIBUSQUE DIGNISSIMUM

We never can forget
Those rubber boots, those bathing suits,
And that collecting net.
Those sings and things will soon take wings
But thru the coming years
Whate'er the scene, dear formaline
Will fill our eyes with tears,
Whate'er the scene, dear formaline
Will fill our eyes with tears.

WOODS HOLE MARINE BIOL. LAB. SONG

Oh the wonderous laws which bind
Living things of every kind,
And control their distribution in the lake,
Temperature and CO_2
Pressure, light, and ions too,
All determined by the tests we've learned to make.

UNIV. OF MICHIGAN BIOL. STA. SONG

Oh we are the students of M.B.L., and a jolly gang are we
We dig, we cut, we fish around from morn till dewy eve
We mutilate the flat worms, and tickle the lobster's toes
And wonder why old Nereis has warts upon his nose.
Wig, wig, wig, wig, wiggle old Nereis goes
Tick, tick, tick, tick, tickle the Lobster's toes,
Exopodite, endopodite, basipodite as well
What happens to these animals I'd surely hate to tell.

CHARLTON, SPEIDEL & KINDRED (1919)

I want to go back to Douglas Lake
The dear old camping ground,
Back to the mess hall on the hill,
Back to the fun in ladyville,
Back to the labs with all their joys
In which we did partake,
I want to go back, I've got to go back
To Douglas Lake.

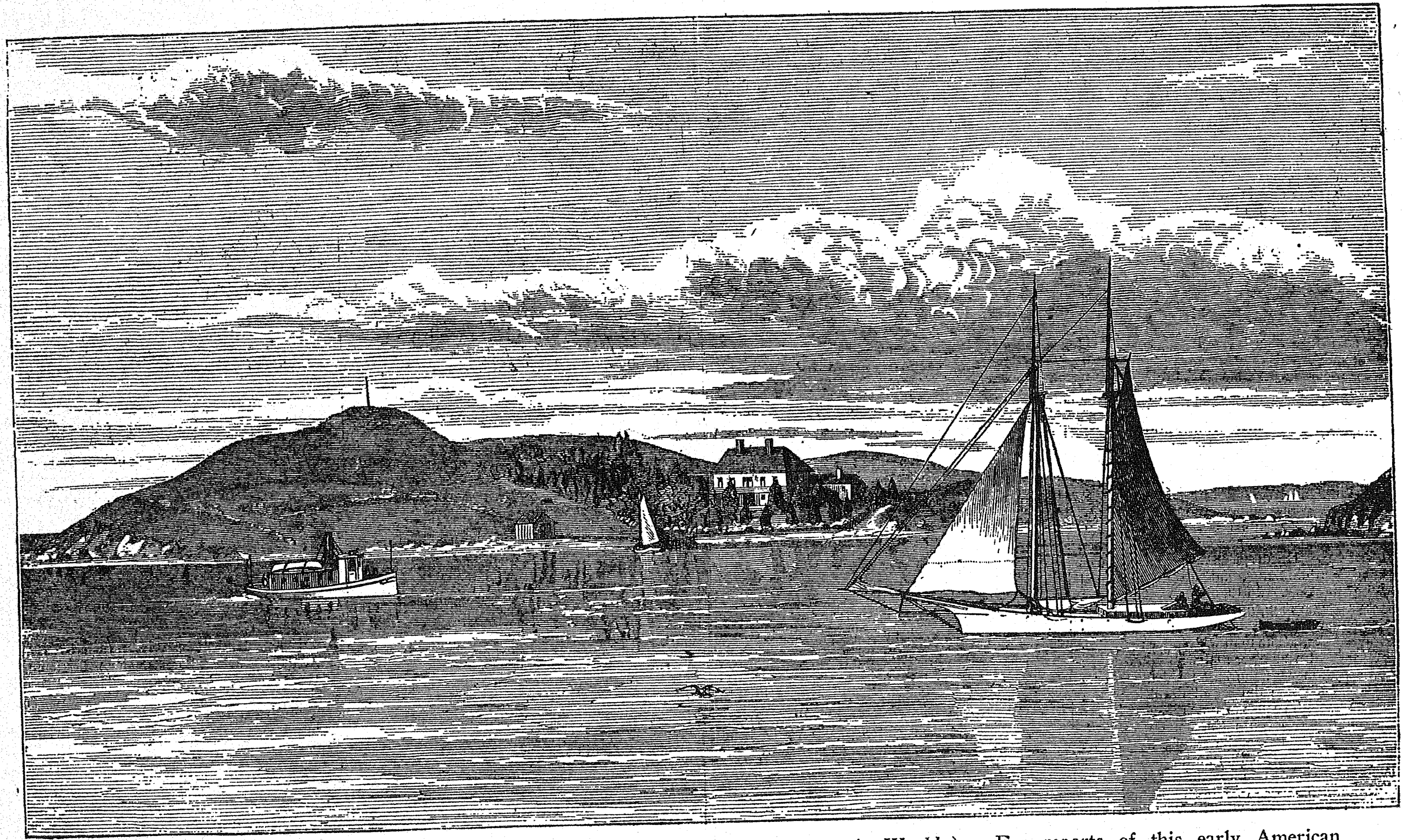
UNIV. OF MICHIGAN BIOL. STA. SONG

There are bugs that make us happy,
There are bugs that make us sore,
There are bugs that spoil our dispositions
Till we never want to see them more,
There are bugs so very complicated
That their heads from tails we cannot tell
But the bugs that fill our hearts with sunshine,
Are the Big Bugs from M.B.L.

WOODS HOLE MARINE BIOL. LAB. SONG

• Chronica Botanica, Volume 9, Number 1 •

BIOLOGICAL FIELD STATIONS *of the* WORLD



AGASSIZ'S SCHOOL ON PENIKESE ISLAND (*Contemporary woodcut from Harper's Weekly*). — For reports of this early American laboratory, founded in 1873 by AGASSIZ, *cf.* bibliography, p. 11. For a recent interesting account see L. C. CORNISH 1943, Sci. Mo. 62:315-321.

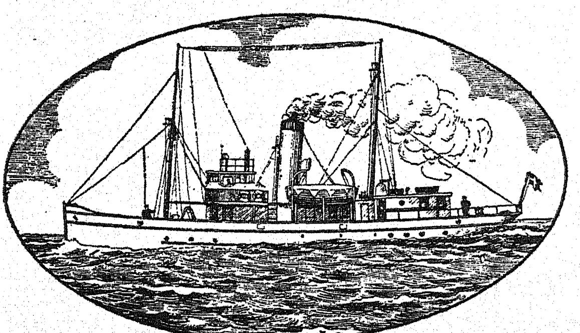
BIOLOGICAL FIELD STATIONS *of the* WORLD

by

HOMER A. JACK

Ph. D. (Cornell), B. D. (Meadville); Executive Secretary, Chicago Council Against Racial and Religious Discrimination; Sometime Lecturer, Athens College, Athens, Greece; Sometime Minister, Unitarian Church, Lawrence, Kansas.

"I have made use of the term 'biological station' in preference to those in more common use for the reason that my ideal rejects every artificial limitation that might check growth or force a one-sided development. I have in mind, then, not a station devoted exclusively to zoology, or exclusively to botany, or exclusively to physiology; not a station limited to the study of marine plants and animals; not a lacustral station dealing only with land and freshwater faunas and floras; not a station limited to experimental work, but a genuine biological station, embracing all these important divisions, absolutely free of every artificial restriction." (C. O. WHITMAN, Science 7:37, 1898)



PRINTED IN THE UNITED STATES OF AMERICA

CONTENTS

The purpose of this study is to synthesize and present heretofore scattered and unpublished materials describing and comparing the biological field stations of the world. If this purpose is partially fulfilled, prospective students and investigators will have a guide to aid them better in selecting a station in which to study or conduct research work. In addition, it is hoped that this study will be of some benefit to the directors of biological stations, since it may show them how their fellow-administrators are solving some of the problems attendant to the efficient organization of these institutions in many parts of the world. Finally, if a theoretical justification for studying these institutions need be given, it is merely that they have loomed large in the progress of biological instruction and research in the past and—providing they retain their adaptability—there is every reason to believe that they will remain equally important in the future.

Although biological stations have been in existence for more than eighty years, there is a paucity of literature about them. Biologists have been prone to leave the study of their institutions to others who rarely have the insight, if the interest, to make extensive analyses (20). The few materials which have been published about biological stations fall into several categories:* 1, *articles on the functions of these institutions, especially by* ANTON DOHRN *(1), Professor* C. O. WHITMAN *(2), and most recently by Professor* PEARSE *(3)*; *2, articles describing a particular station; 3, articles on several stations of a region or functional group; and* 4, *articles in the form of a directory of the stations in larger political units.*

The first directory for any large political or geographical area was published in 1893 by BASHFORD DEAN *(4). This consisted of a discussion of the marine laboratories of Europe. It was followed in 1898 by* RENÉ SAND'S *account (5) of the biological stations of the world. In 1899* HENRY WARD *(6) published a paper on the freshwater biological stations of the world and in 1910* CHANCEY JUDAY *(7) wrote an account of European biological stations.*

The first extensive study of biological stations was made in 1910 by Professor KOFOID *in his bulletin on the "Biological Stations of Europe" (8). In 1927* LENZ *(9) published his valuable directory of limnological laboratories and in the same year* MAGRINI *(10) issued his list of institutions occupied with the study of the sea. In 1928 the General Biological Supply House of Chicago began to publish its annual booklet on "Biological Field Work" (11) at North American stations. Professor* T. W. VAUGHAN *in 1937 issued his important "Catalogue of Institutions Engaged in Oceanographic Research" (12) and in that same year the author's unpublished study (13) on the biological field stations of the United States was completed.* CHRONICA BOTANICA *(14) in 1938 published a world list of scientific institutions which contained a more complete enumeration of biological stations than had ever appeared in the editions of "Minerva," "Index Generalis" or "Index Biologorum." In 1940, the author published a short description of the United States stations in "The American Biology Teacher" (15) and a series of articles on the European stations in "The Collecting Net" (16). Also in 1940 the author completed his unpublished manuscript on "The Biological Field Stations of the World" (17), of which this study is a part.*

In addition to reviewing the existing literature, the author tried to study these institutions first-hand. Besides being a student and investigator at two stations for five summers, the author attempted to visit as many of these institutions as his time and resources permitted. Seventy-nine stations in eighteen countries in Europe, North Africa, and North America were visited by the author between 1937 and 1941. These visits and interviews (18) were supplemented by questionnaires in English and French to the directors of the stations not visited.

It must be emphasized that, with few exceptions, the descriptive and analytic accounts of the biological stations given in this study are corrected to 1940—before the second World War became world-wide. As the war progressed, many of these institutions greatly curtailed their activity and even suspended operation for the duration

* Notes and references will be found at the end of this introduction and at the end of each part of the first section of this account.

of the war. Indeed, a few stations were casualties of the war (19). Despite these changes wrought by the war, it has been thought useful for biologists and other scientists to have a picture of the biological stations of the world at perhaps the peak of their operation (1939-40). Thus even before the war is over or sectional armistices are declared, information on these institutions will be in the hands of those who, as students, investigators, and administrators, will be responsible for helping to make them again serve science and mankind.

Many biological stations normally print descriptive catalogues giving seasonal or up-to-date information on the research and instructional facilities available. Prospective students and investigators are urged to send for such a catalogue and correspond with the director before making definite arrangements to attend any station. If desired, the author through one of the CHRONICA BOTANICA *publications will continue to act as a clearing house for information about these institutions. And if there is a demand, perhaps a second, post-war edition of at least the descriptive portion of this study can be issued.*

The author is under deep obligation to all those who have helped to make this study possible, especially to Professors EDWIN CONKLIN, E. A. ANDREWS, *and* JACOB REIGHARD *who, as patriarchs of biological field work in America, have given him valuable historical materials; to Professors* E. LAURENCE PALMER, ALBERT HAZEN WRIGHT, *and* LEONARD S. COTTRELL, JR., *of his graduate committee at Cornell University; to Professors* ROBERT E. COKER *and* GEORGE R. LARUE *who, as former directors of the Allegany School of Natural History and the Biological Station of the University of Michigan respectively, accepted the author as a student in their institutions before he matriculated in college; and to Dr. and Mrs.* FRANS VERDOORN, *without whose aid and encouragement this study could not have been published.*

The author is grateful to the directors of all of the biological stations for helping him to compile the descriptive part of this study and often for giving him hospitality during his brief visits to many of these institutions. The author is especially grateful to Dr. W. BEIJERINCK *of the Biologisch Station at Wijster, Professor* J. BRAUN-BLANQUET *of the Station Internationale de Géobotanique Méditerranéenne et Alpine, Professor* ATTILIO CERRUTI *of the Istituto Demaniale di Biologia Marina di Taranto, Dr.* C. CROSSLAND *formerly of the Marine Biological Station of the Fouad I University, Professor* ODÓN DE BUEN *formerly of the Instituto Español de Oceanografía, Dr.* ROBERT B. GORDON *of the Allegany School of Natural History, and Dr.* F. RUTTNER *of the Biologische Station Lunz.*

Above all, the author is deeply indebted to his parents, CECELIA *and* ALEXANDER JACK, *who sought in every possible way to give him opportunity for study and travel. To them, this study is dedicated.*

CHICAGO, ILLINOIS, U. S. A.
5701, S. WOODLAWN AVE.

References and Notes: — (1) The foundation of zoological stations. Nature 5:277-80, 437-40, 1872. Also, Report of the committee . . . for the foundation of zoological stations in different parts of the globe. Report of the British Association for the Advancement of Science 1873:408-12, 1874. — (2) Some of the functions and features of a biological station. Science 7:37-44, 1898. — (3) A. S. PEARSE: Marine biological stations. Tennessee Academy of Science 17 (4):345-47, 1942. — (4) Notes on marine laboratories of Europe. American Naturalist 27:625-37, 697-707, 1893. Also this article may be found in the Report of the Smithsonian Institution for 1893, pp. 505-19, 1894. — (5) Les laboratoires maritimes de zoologie. Revue de l'Université de Bruxelles 3:23-47, 121-51, 203-35, 1898. — (6) The freshwater biological stations of the world. Science 9:497-508, 1899. Also this article may be found in the Report of the Smithsonian Institution for 1898, pp. 499-513, 1899. — (7) Some European biological stations. Transactions of the Wisconsin Academy of Sciences, Arts, and Letters 16:1257-77, 1910. — (8) CHARLES ATWOOD KOFOID: The biological stations of Europe. United States Bureau of Education Bulletin 1910 (4):1-360, 55 pls., 48 figs., 1910. — (9) F. LENZ: Limnologische Laboratorien. Handbuch der Biologischen Arbeitsmothoden 9:2(1):1285-1368, 1927. — (10) G. MAGRINI: Instituts et laboratoires s'occupant de l'étude de la mer. Conseil International de Recherches, Union Géodésique et Géophysique Internationale, Section d'Océanographie, Bulletin 7:1-115, 1927. — (11). This appeared in 1928, 1929, 1930, 1931, 1932, 1934, 1935, 1937. Mimeographed lists of the biological stations of the United States and Canada were issued by this supply house in 1938 and 1939. In 1940 the list appeared in Turtox News 18(3):49-51. — (12) *In* International aspects of oceanography (T. W. VAUGHAN and others). Washington:

National Academy of Sciences. 1937, pp. 73-225. — (13) HOMER A. JACK: Biological field stations—their history, organizations, educational contributions, and conservation relations. 196 pp., 26 figs., 37 tables. (Unpublished thesis, Cornell University Library). 1937. — (14) FRANS VERDOORN (*ed.*): World list of institutions, stations, museums, gardens, societies, and commissions. Chronica Botanica (Leiden) 4(4-5):301-83, 1938. — (15) HOMER A. JACK: Close to nature: biological field stations. The American Biology Teacher 2:141-45, 180-83. 3 figs., 1940. — (16) HOMER A. JACK: The biological field stations of Europe. The Collecting Net (Woods Hole) 15:5-6; 25, 31-33; 45, 51-52; 70-71; 96-98; 117-18; 137-38; 152-53; 184-86; 206-08, 1940. — (17) HOMER A. JACK: The biological field stations of the world—A comparative and descriptive study. 1,001 pp., 114 tables, 4 plates. (Unpublished thesis, Cornell University Library). 1940. This may be obtained from the Cornell University Library through inter-library loan. — (18) *Cf.* HOMER A. JACK: Language difficulty. Science 89:558. 1939.—(19) "During the recent air raids of Plymouth, the Laboratory of the Marine Biological Association suffered severely. The buildings, though still standing, have sustained heavy damage. All windows except a few on the south side of the top floor of the main building have gone; ceilings are down, doors wrenched off, and much structural damage caused by the blast. The director's house was completely burned out. The library, very fortunately, is intact except for the loss of windows and the skylight, and it has now been made waterproof . . . The Easter class house will no doubt have to be rebuilt, but most of the roof remains. Other buildings, including the dogfish house, director's garage and stores, and the constant temperature rooms, have all sustained damage . . . The tanks on the north side of the Aquarium burst and the supply pipes broke, but it is hoped that some part of the circulation may be restored before very long . . ." (*cf.* Science 93:445). — (20) An outstanding exception is The Woods Hole Marine Biological Laboratory, *by* FRANK R. LILLIE. University of Chicago Press, 284 pp., 1944.

The Purpose of Biological Stations: — A biological field station may be considered as any institution which offers field instruction or research in one or more of the theoretical biological sciences and is a separate administrative unit located in the field. In the actual practice of the institutions, the pendulum has swung between research and instruction several times. And the problem has always been, as Professor C. O. WHITMAN posed it in 1893, "to combine the two [instruction and investigation] in such relations that each would contribute most to the same end — the advancement of science"[1].

Nineteenth Century Stations. — In the nineteenth century, three principal types of biological stations evolved. The first kind of station to develop in Europe was the seaside laboratory and aquarium. Facilities were furnished for marine research, with a public aquarium being maintained principally to subsidize the research work of the institution. The Zoological Station of Naples fell into this class. Its founder, Dr. ANTON DOHRN, rightfully called it "a battlefield where all the different zoological armies [systematists, anatomists, physiologists, and embryologists] may meet and fight their common adversaries [error and ignorance]"[2].

Quite opposite in purpose was the seaside school of natural history which was the first kind of station to appear in America. Its aim was to offer marine instruction to students and teachers. With the establishment of this type of station, of which LOUIS AGASSIZ's Anderson School of Natural History was representative, the battle royal began. Professor E. RAY LANKASTER, for example, wrote contemptuously in 1880 of AGASSIZ's venture, "the spasmodic descent upon the seacoast in a summer vacation . . . is a delightful thing . . . but it is not in this way that the zoology of today can be forwarded"[3].

Toward the end of the nineteenth century, a practical compromise was reached in this controversy with the rise of the third kind of station, the

so-called marine observatory. Here both marine research and instruction were combined to varying degrees. The Marine Biological Laboratory at Woods Hole, Massachusetts, was a representative of this type of station. Professor WHITMAN, its director, realistically described its practice when he said, "instruction . . . was accepted more as a necessity than as a feature desirable in itself. The older ideal of research alone was still held to be the highest, and by many investigators was regarded as the only legitimate function of a marine laboratory"[4].

Twentieth Century Stations. — It had been occasionally implied that biological stations made their maximum contribution to the progress of biology during the nineteenth century and that in the twentieth century they would decline. Not only have these institutions survived, but they have flourished, principally due to their adaptability from nineteenth century patterns to twentieth century needs. The typical biological station of the twentieth century has been organized to encourage research and instruction in one or more of the biological sciences by offering facilities for these types of work in one or more kinds of environments. This emphasis on various environmental conditions, in addition to the seaside, was envisaged by Professor WHITMAN, "I have in mind . . . not a station limited to the study of marine plants and animals; not a lacustral station dealing only with land and fresh-water faunas and floras . . . but a genuine biological station, embracing all these important divisions"[5]. In addition to exploring new types of biological environments, typical biological field stations have often sponsored actual research projects. Also there has been a new appreciation of the importance of instruction. As Professor WHITMAN prophetically stated, "with increase and specialization in science the investigator himself becomes more and more dependent upon the instruction which he draws not only from books and journals, but also directly from his colleagues and his pupils. . . We could not wisely exclude instruction [from biological stations] even if made free to do so by an ample endowment"[6].

Despite the rise in the twentieth century of the typical biological station which offers both research and instruction, a number of contemporary institutions have confined themselves either to research or instruction. The biological research station confines itself solely to providing opportunities for research in addition to carrying on research projects of its own. Thus Dr. REINHARD DOHRN re-emphasized the original purpose of the twentieth century Zoological Station of Naples, "It was founded to enable naturalists to carry on their studies with the utmost economy of time, energy, and money. This is still, in my opinion, its fundamental *raison d'être*"[7]. Opposed to the biological research station is the biological nature camp, an institution largely American in origin. Its purpose is to train students in elementary field biology (*i.e.,* nature study).

Quantitatively, it is estimated that about one-half of the contemporary biological stations in the world are biological research stations, offering no facilities for instruction. About two-fifths of the world's stations offer both facilities for instruction and research, while about one-tenth of these institutions offer instructional facilities only. For the stations in the United States, the proportion differs: slightly less than one-half are typical biologi-

cal field stations offering both instruction and research; one-fourth are biological research stations; and almost one-third are biological nature camps.

Perhaps a case could be made for the relationship between the longtime political and educational philosophies of a country and the purposes of the biological stations within its borders. It is worth noting that some of the democracies with a tradition for popular education emphasize formal instruction at the biological stations within their borders (*e.g.,* three-quarters of the United States stations and more than two-thirds of the British stations), while some political areas without a long democratic tradition emphasize research (*e.g.,* more than one-half of the German stations, more than four-fifths of the Russian stations, and all of the Italian stations).

References:—(1) Pop. Sci. Mon. 42:459-71, 1893. — (2) Rept. Brit. Assoc. Advan. Sci. 1873:408-12, 1874. — (3) Nature 21:497-99, 1880. — (4) Science 7:37-44, 1898. — (5) *Ibid.* — (6) *Ibid.* This was reaffirmed forty years later by the trustees of the Marine Biological Laboratory. *Cf.* FRANK R. LILLIE: The Woods Hole Marine Biological Laboratory. University of Chicago Press, p. 92, 1944. — (7) Nature 113:449-50, 1924.

The History of Biological Stations: — From the incomplete historical material available, it appears that the first biological station — as the term has been previously defined—was established in 1859 at Concarneau, France. Earlier in the nineteenth century, biologists came to recognize the value of staying in one place long enough to be able to study living materials in their natural environment. As Professor R. LEGENDRE said, "Bientôt, la simple récolte et la seule dissection ne suffirent plus"[1]. In the eighteen thirties some Swedish naturalists established what Professor CHARLES A. KOFOID called "an impromptu summer biological station"[2]. In 1843 at Ostend, Belgium, Professor P.-J. VAN BENEDEN founded what RENÉ SAND[3] considered the first biological station in the world. LEGENDRE likewise said that this was "le premier centre d'études maritimes,"[4] although KOFOID[5] considered it as merely a kind of formalized seaside excursion and not the first biological station in the world. In that same decade Professor CARL VOGT made several unsuccessful attempts to establish a biological station and in 1848 Professor VALENCIENNES, an associate for a time to Baron CUVIER, began to explore the coast of Brittany for biological specimens. His efforts resulted in the establishment, in 1859, by Professor J. J. COSTE of what exists today as the Laboratory of Marine Zoology and Physiology of the College of France at Concarneau. Fourteen years later, the first station was founded in North America: LOUIS AGASSIZ's Anderson School of Natural History on Penikese Island[6]. About the same time Dr. ANTON DOHRN founded the Zoological Station of Naples.

Their Increase. — The biological station idea spread swiftly and in many directions from its original centers in northwestern France (Concarneau) and in northeastern United States (Penikese Island). In the decade ending in 1880, sixteen biological stations were established, scattered between Sweden and the Black Sea in Europe and Illinois and Virginia in the New World. And by 1888 both the Marine Biological Laboratory at Woods Hole, Massachusetts, and the Laboratory of the Marine Biological Association at Plymouth, England, were in operation. The greatest number of

field stations were founded in the decade ending in 1930, when seventy new ones were established. Although these institutions have almost continuously been abandoned, there has been a net increase in the number of new stations established each decade, with a notable lessening of this increase in the decade including the first World War and the decade after the depression of 1929.

Their Founders. — Biological field stations have been established by many different types of individuals and institutions. Although most biological stations exist, at least in part, to aid scientific research work, scientists themselves have not always had the financial resources to establish these institutions. There have been a few scientists (*e.g.*, ANTON DOHRN or ALBERT I, Prince of Monaco) who have been able to use their private fortunes to build up biological stations. Less wealthy scientists have had to use their personalities to persuade others to give. Both royalty (*e.g.*, King FERDINAND I of Bulgaria) and business men (*e.g.*, JOHN ANDERSON) have been patrons for the establishment of these institutions.

Most biological stations, however, have been established by the help of an institution or special committee, with some one scientist taking the administrative initiative. A list of the types of institutions which have aided in the establishment of biological stations include governmental departments (*e.g.*, Danish Ministry of Agriculture), national scientific institutions (*e.g.*, Carnegie Institution of Washington), national scientific societies (*e.g.*, Netherlands Zoological Society), universities (*e.g.*, University of Kiel), local institutions and societies (*e.g.*, Berlin Museum), and colleges (*e.g.*, South Dakota State College). Occasionally special committees have been founded for the express purpose of starting a biological station. These have been international (*e.g.*, Jungfraujoch Scientific Station), national (*e.g.*, Freshwater Biological Association of the British Empire), and local (*e.g.*, Liverpool Biological Committee).

More than one-half of the stations in the United States have been established by universities or colleges. There is apparently a world-wide trend away from the foundation of these institutions by private individuals. This might be explained by the fact that the organization of a field station involves greater expenses than formerly, when an individual scientist with a few students, much enthusiasm, and little equipment could establish a station or induce a rich patron to finance one.

Their Development. — Once a station is founded, it is naturally often not equipped to cope with all the problems which it often must face. Several stations have experienced considerable delay between the time they were started and the time their instruction or research program was begun. And being very dependent upon the immediate natural environment, some stations have had to move from their original sites, because of the unfortunate choice of the original site or because of the encroachment of civilization.

Their Abandonment. — Biological stations have been abandoned for a number of reasons. The most common causes for discontinuance have been the death of the founder or director (*e.g.*, LOUIS AGASSIZ's death soon brought an end to the Anderson School of Natural History), fire (*e.g.*, Cornell University Biological Station), marine disaster (*e.g.*, the wreckage

of the *Pourquoi Pas?*), war (*e.g.*, Royal Hungarian Marine Biological Station), curtailment of funds (*e.g.*, The Biological Station of the United States Bureau of Fisheries at Woods Hole), and personal disagreements (*e.g.*, Mountain Laboratory of the University of Utah).

Since the first biological station was founded, at least ninety of these institutions — approximately one out of four established — have gone out of existence. The life span of abandoned stations has varied widely. One institution (*i.e.*, The Biological Station of the United States Bureau of Fisheries at Woods Hole) closed after being in operation fifty-one years. Others (*e.g.*, Lake Cooper Biological Laboratory) have closed their doors after one season. The average length of life of the abandoned stations has been about sixteen years. The average length of life of those stations existing in 1940 was about twenty-six years, with the oldest founded in 1859 and the youngest founded in 1940.

References:— (1) Revue Scientifique 70:750-53, 1932. — (2) U. S. Bur. Educ. Bull. 1910(4):1-360, 1910. — (3) Rev. Univ. Bruxelles 3:23-47, 121-51, 203-35, 1898. — (4) Revue Scientifique, *op. cit.* — (5) U. S. Bur. Educ. Bull., *op. cit.* — (6) *cf.* Harper's Weekly 17:701-02. Popular Science Monthly 40:721-29. Nation 17:174-75. *Ibid.* 31:29. American Naturalist 32:189-96. Nature 6:34. *Ibid.* 8:454-55. *Ibid.* 11:167-68. *Ibid.* 21:497-99. *Ibid.* 31:174-75. Science 58:273-75. Literary Digest 79:68-69. New York Daily Tribune, March 12, 1873. *Ibid.* March 27, 1873. *Ibid.* July 9, 1873. *Ibid.* July 10, 1873. New York Times, March 27, 1873. *Ibid.* April 23, 1873. *Ibid.* May 22, 1873. Frank R. Lillie: The Woods Hole Marine Biological Laboratory. University of Chicago Press, pp. 15-23, 1944. Sci. Mon. 62:315-21.

The Location of Biological Stations: — The uniqueness of biological field stations lies in their location, in the opportunities they offer students and investigators to study biological forms at close range in their natural environment. While political, geographical, and other considerations enter into the establishment of biological stations, these institutions are usually located on sites near or within a unique biological environment, or else in an area where an abundance and variety of biological forms are easily accessible. Some believe the ideal to be an itinerant station or a "floating station," which provides more freedom to move to new sites frequently or periodically. Similar results in extending the working radius of a station have been obtained by establishing annexes or by removing a whole station to a new site after a period of years.

Ecological Location. — About one-half of the stations of the world are marine biological stations. The remaining ones are about evenly divided between being primarily situated for work in fresh-water biology and in terrestrial biology. While biological stations have penetrated the arctic (*e.g.*, Greenland), the desert (*e.g.*, Morocco), and the jungle (*e.g.*, Panama), there are many biological areas in the world possessing none of these institutions. Professor T. W. Vaughan has pointed out the "paucity of oceanographic stations south of the equator"[1]. Some of the larger areas without biological stations include Lake Victoria, the Caspian Sea, the Himalaya Mountains, the Andes Mountains, the tropical forests of Africa and South America, the prairies of Patagonia, the steppes of Tibet, and the deserts of Mongolia.

Political Location. — The estimated 265 biological stations in operation in 1940 were distributed in fifty-eight political divisions. The United States led in the number of existing field stations with sixty-three. Other

countries with a relatively large number of biological stations include the U. S. S. R. with twenty-three, France with twenty, Germany with fourteen, Japan with twelve, and Italy with ten. There are also a number of countries which, in 1940, had no biological stations within their borders. These include Turkey, Greece, Ethiopia, Iceland, and New Guinea.

There is little or no correlation between the population or size of a country and the number of biological stations it supports. Switzerland, for example, has one field station for about every 2,600 square miles of its territory, while Brazil has but one station for every 1,000,000 square miles of its land. For the political areas which have field stations, the mean figure is one station for about every 28,000 square miles. The number of inhabitants theoretically supporting a biological station also varies greatly. Every 400,000 persons in the Mountain States of the United States support a biological station in that territory. In China, on the other hand, there is only one station for every 140,000,000 inhabitants. The mean figure (for those areas having these institutions) is one station for about every 3,000,000 persons.

The greater the number of biological stations a country supports, the greater theoretical support that nation gives to biology. Such might be true if biological stations were of the same size and had approximately the same scientific output. When, however, the actual factor of size or output is considered, a country like Hungary with only one biological station is perhaps supporting more field biological research and instruction than Czechoslovakia with six of these institutions. Traditionally, some countries have followed a conscious or unconscious policy of dissipating their resources by establishing a number of small stations rather than fewer big ones. Professor HENRI LACAZE-DUTHIERS warned in the last century, "we have been able to count as many as seventeen or eighteen stations on our coasts [France] in the course of 1891. . . Is this not also an exaggeration and a dissipation of precious energies which, if concentrated into a single strong organization, might render very great service?"[2].

References: — (1) International Aspects of Oceanography. Washington: National Academy of Sciences. 1937. — (2) Arch. Zool. 2(9):255-363, 1891.

The Administration of Biological Stations: — Biological stations are sponsored by several types of organizations and institutions. They are organized usually as separate administrative units of the institution or organization which sponsor them. A director is generally appointed by the sponsoring committee to manage the work of the station. While the director's duties are concerned primarily with all the problems attendant to translating into action the educational and scientific philosophy of the institution, the two administrative problems with which most station directors are especially occupied are balancing the station's budget and giving the station the kind of publicity which will make the desired number of students and investigators attend the institution each session.

Sponsorship. — Biological stations usually have not sufficient financial strength to be autonomous institutions. Although separate administrative units, they are sponsored by various types of organizations and individuals. Universities and colleges appear to be the most frequent sponsors of con-

temporary biological stations. More than one-half of the stations in the United States are so supported. Scientific institutions and organizations less frequently play the role of sponsors of biological stations (*e.g.*, The Royal Society of Göteborg supports the Oceanographic Institute of Göteborg, Sweden). Governmental departments are also the sponsors of biological stations (*e.g.*, the Egyptian Ministry of Commerce and Industry supports the Fouad I Institute of Hydrobiology and Fisheries at Alexandria). In some cases, several types of organizations combine to support a biological station (*e.g.*, The Laboratory of Zoology of the University of Iaşi and the Ministry of National Education together sponsor the Marine Zoological Station "King Ferdinand I" at Agigea, Roumania). A few of these institutions are sponsored by private individuals (*e.g.*, Dr. FRIEDRICH MORTON is the sole supporter of the Botanical Station at Hallstatt, Austria). Lastly, about one-tenth of the biological stations are autonomous, being sponsored by an organization formed specially for that purpose (*e.g.*, The Bermuda Biological Station for Research is an institution founded and incorporated for the sole purpose of supporting its own scientific work)[1].

Organization. — Most biological stations are organized as more or less autonomous departments of the organizations or institutions which sponsor them. The parent institution usually appoints a kind of executive committee which in turn appoints a director in whom is vested most of the administrative duties. Those stations which are truly autonomous institutions often present the greatest administrative problems because they have no sponsoring institutions after which to pattern their organization and with which to integrate their functions. They often find it best to have a formal board of trustees. The executive committees or boards of trustees of the larger stations issue annual reports of the work of the institution. While most often they are summaries of research (*e.g.*, Report of the Reelfoot Lake Biological Station), occasionally they are administrative summaries (*e.g.*, Report of the Marine Biological Laboratory, Woods Hole, Mass.).

Directors. — The bulk of the administrative work of most biological stations falls upon the directors of these institutions. They are usually appointed to these positions by the executive committee or the board of trustees. Not infrequently in the case of younger stations, the directors have assumed their positions by being the founders of the institution (*e.g.*, ANTON DOHRN, founder and first director of the Zoological Station of Naples). About one-quarter of the directorships are full-time positions. Most of the stations, however, are in operation only a portion of the calendar year and consequently these positions are part-time ones. During the greater part of the academic year, the directors are usually university or college professors, although their vocations vary from that of a superintendent of schools to a drug store proprietor. In any case, the directors are scientists, most often, zoologists.

Finances. — The financial problems facing the directors of biological stations are those facing most other institutions: how to obtain an adequate income and how to spend it wisely. Biological stations obtain the largest share of their income from the services they render in providing facilities for research and instruction to investigators and students. Even so, most

of these institutions are unable to meet their expenses through tuition and laboratory fees and must turn to supplementary sources of income. These include income from their sponsoring organizations (in the form of direct subsidies), from the government (for scientific services), and from the public (for admission to aquariums). Autonomous institutions must seek even a wider source of income which often include outright government grants, endowments, the sale of biological specimens, and membership and patron fees. Once acquired, the income of biological stations is expended on administration, instruction, research, and the maintenance and operation of laboratory and living facilities.

The actual budgets of biological stations vary with their purpose, size, and age. The Marine Biological Laboratory has had the largest budget: $185,096 in 1938. Several of these institutions, on the other hand, have annual budgets of less than one thousand American dollars (*e.g.*, Biological Laboratory of Lake Orédon, France, has an annual budget of 4,000 francs or $106). Any attempt at obtaining an average budget is meaningless because of the varying currencies, standards of living, and even accounting practices. It is worth noting, perhaps, that England has an average yearly budget of $28,470 per station, whereas Italy has an average annual budget of $421 per station (excluding the international Zoological Station of Naples). The average annual budget of one-half of the existing United States stations is $21,130.

Publicity. — Since the financial success of most biological stations is very much dependent upon the attendance of a full quota of students and/or investigators, various publicity practices have been devised to attract these students and investigators. In the United States, it has been the custom for most of these institutions to issue annual announcements of their available facilities. About three-quarters of the United States stations publish such announcements. They may vary from a one-page mimeographed sheet (*e.g.*, the 1940 announcement of the San Francisco State College Science Field Session) to a 35-page booklet (*i.e.*, 1940 announcement of the Marine Biological Laboratory). The stations in the United States which do not issue annual announcements are either in the early stages of existence or offer only research facilities, in which case a detailed printed announcement may serve for several years. Several of the American stations supplement the publicity given in their annual announcements by inserting news notices in the unpaid columns of certain scientific journals (*e.g.*, *Science*) or paid advertisements in others (*e.g.*, *Nature Magazine*). In Europe, station announcements more often take the form of one-page brochures, printed annually and describing the current offerings in instruction or research. These are often supplemented by printed rules and regulations which are issued irregularly.

Directors of biological stations often obtain general publicity for their institutions by cooperating in the production of general articles about the work of the station in popular publications (*e.g.*, Machete Trails by DALLAS L. SHARP in *The Atlantic Monthly* in 1930). They also coöperate in the compilation of directories of the biological stations of a political or geographical area (*e.g.*, the 1937 issue of *The Biologist* [Phi Sigma Society] devoted to Biological Summer Schools). The most effective kind of publicity for

the biological stations of all countries results from the unqualified satisfaction and enthusiasm of students and investigators who have attended these institutions. Some stations have attempted to sustain this enthusiasm by organizing loosely-formed alumni associations with irregular meetings and newsletters.

Note: — (1) LILLIE shows the advantage of autonomous organization in "freedom from all restrictions of local institutional control." *Cf.* FRANK R. LILLIE: The Woods Hole Marine Biological Laboratory. University of Chicago Press, p. iii, 1944.

The Equipment of Biological Stations: — The kind of equipment with which a biological station is able to carry out its program depends upon its purposes and its resources, to a lesser extent upon its ecological and political location. Most biological stations have some sort of campus on which are constructed one or more buildings. These are equipped with laboratories and scientific apparatus for instruction and research. In addition, these institutions are also equipped to furnish board and lodging for those in attendance. There are a few itinerant stations which often have the same problems and needs of the stationary institutions and therefore have much of the same equipment, except a permanent campus and buildings.

Buildings. — In planning the laboratory buildings for the Anderson School of Natural History, LOUIS AGASSIZ stated, "I was determined that we should not be satisfied with that mode of proceeding of which we have so many examples in these medieval castles for the abode of modern science. I wanted, if possible, that our rooms should correspond at once with our work"[1]. While most directors have perhaps had this philosophy of planning, they usually have not had the financial opportunity to put such architectural theories into practice in establishing or even subsequently enlarging these institutions. Several stations have started and often continued in buildings erected for other purposes: the Murman Biological Station in a monastery, the Oregon Institute of Marine Biology in an abandoned Civilian Conservation Corps camp, the Zoological Station at Villefranche in an abandoned coaling station, the Hydrobiological Section of the Scientific Institute of Peterhof in an appropriated country estate, and the Laboratory of the Fresh-water Biological Association at Ambleside, England, in veritably a medieval-looking castle.

The size of biological stations is not usually proportionate to the number of buildings, but rather to what they contain. Thus the Zoological Station of Naples is housed in one building whereas the smaller Allegany School of Natural History maintained forty-seven building units. In general, biological stations can be classified into small, medium, and large plants. The smallest number of stations have relatively large plants. The ten top-ranking institutions in regard to the size of their physical plants probably would include, though not necessarily in the order given, those stations at Woods Hole (Marine Biological Laboratory), Naples, Plymouth, Helgoland, Woods Hole (Woods Hole Oceanographic Institution), La Jolla, Friday Harbor (and Seattle), Monaco, Roscoff, and Cold Spring Harbor. All except the last-named institution happen to be chiefly equipped for marine research. The largest inland biological stations would probably include those at Douglas Lake, Michigan; Put-in-Bay, Ohio; Lunz, Austria; and Jungfraujoch, Switzerland.

Laboratories and Apparatus. — Whatever their size, biological stations contain various types of laboratories and rooms equipped with apparatus with which to carry on their different functions. Increasingly this apparatus has become more complicated than the original equipment of the early field stations. Today even small stations are supplied with fairly intricate apparatus which never enters the field in the sense that it never leaves the laboratory.

The laboratories and apparatus of biological stations serve primarily for general research and instruction. In addition, a number of these institutions are also equipped for research in special fields, for photography, for collecting, for repairing, and for distributing supplies. The other functions for which many biological stations are equipped include public education, miscellaneous services, and library work.

Apparatus for General Biological Research. — Most field stations, even if they have no laboratories equipped for special functions, do have at least one room equipped for general biological research. Such equipment includes laboratory furniture, common chemicals and glassware, running fresh-water (and often sea-water), small aquariums or terrariums, electricity, and occasionally gas, compressed air, and vacuum pipes.

Those stations which have piped sea-water usually take precautions to insure the purity of the water, both at its source and during its conduct through pipes to the desk of the student or investigator. As Professor Kofoid observed, "much may be done by sedimentation and by preliminary storage in the dark to improve polluted waters for circulation in aquaria and laboratories; but, after all is said, purity of water supply is the greatest asset of the marine station"[2]. At least one station (*i.e.,* Bergen Museums Biological Station) has had to change its site because of the contamination of the waters adjacent to its original location. Another institution (*i.e.,* Oceanographic Institute of Göteborg, Sweden), desiring a certain type of sea-water, obtains it by freighter from the Bay of Biscay.

Apparatus for Instruction. — The nature of the instruction offered at biological stations is usually such to necessitate only the minimum of instructional apparatus. For those courses demanding inside laboratory work, class rooms and laboratories have to be provided. These often contain the apparatus furnished to the general research laboratories. In addition, they are often equipped with blackboards, charts, and microscopes. A few stations have special lecture rooms, although at most of these institutions, the lectures — if any — are of an informal nature, being often given in the laboratory or during a field trip.

Apparatus for Special Services. — Laboratory apparatus is often supplied for research in various special fields of science. While these fields vacillate with the trends in biology, the more common ones are bio-chemistry, physiology, and taxonomy. Other subjects for which one or more biological stations are especially equipped include bio-physics, economic fisheries, hydrography, bacteriology, and microscopy.

Photography is an important aid to field instruction and research. Most biological stations are equipped with rooms to develop and print photographic negatives. While most stations usually have only one darkroom,

the larger institutions often have several which are well-equipped with developing and printing apparatus.

Since the collection of scientific specimens has increasingly become an art, complicated equipment and even highly-trained personnel are needed. Many stations maintain boats and automobiles for collecting purposes. The boats vary greatly in number and size. Some stations use and need only rowboats and canoes. Others have large vessels, such as the 112-foot *Makrele* of the Biological Station of Helgoland. A few boats have been specially-built for scientific work, such as *The Atlantis*[3] of the Woods Hole Oceanographic Institution[4]. Stations which do have boats must have places to keep them and often employees to run them. In addition to operating boats, the stations which do a large amount of collecting must have employees who, if not formally-trained scientists, must know enough practical biology to be able to go out in the station's vessel and find the various biological forms that are wanted. One of the most famous of such collectors was SALVATORE LO BIANCO who for many years was conservator of the Zoological Station of Naples.

As scientific apparatus is used at biological stations — as elsewhere — it needs adjustment, becomes broken, or wears out. At institutions situated in isolated places or at the larger ones, it is often expedient for the station itself to attempt to adjust, repair, or make research apparatus. To meet these needs, several stations have well-equipped shops for machine-work, carpentry, and glass-blowing.

Most stations have had to be equipped for the distribution of scientific apparatus and supplies to those in attendance. Equipment for this purpose at the larger institutions includes stock rooms, station stores, and, in several instances, whole departments for the sale of live and preserved biological forms.

Apparatus for Public Education. — The public education attempted by biological stations is usually by means of aquariums, museums, and botanical gardens. The more ambitious of each of these projects demands elaborate equipment and personnel. The aquariums vary in size from small, one-room exhibits in table tanks to very large installations as at the stations at Naples, Helgoland, and Monaco. Public museums also are often operated in conjunction with the marine aquariums (*e.g.*, Monaco). Botanical gardens are maintained by several stations. While they do not entail much equipment, they usually require the services of several gardeners and laborers to give them the constant care required for their successful operation.

Apparatus for Miscellaneous Services. — One of the auxiliary functions of field stations is the securing of regular hydrographic and meteorological observations, often in coöperation with other agencies (*e.g.*, the Weather Bureau and the Coast Guard in the United States). The equipment necessary to take these observations varies from simple thermometers and rain gauges to tidal stations and apparatus for measuring direct and diffuse solar radiation (*e.g.*, Oceanographic Laboratories of the University of Washington).

Other functions for which many biological stations must be equipped are administration and transportation. While much of the administrative work in connection with the conduct of biological stations is often carried

A VIEW OF THE LABORATORIES AT WOODS HOLE, CAPE C

on at the offices of the sponsoring institutions, many need some kind of office and secretarial aid in the field. Likewise, while individuals often provide their own transportation to biological stations, these institutions must often provide transportation for classes and supplies. This is done by means of various types of boats and automobiles. While most stations in the United States have one or more automobiles, only a few institutions in Europe or elsewhere have such vehicles.

Library Facilities. — Most biological stations have some kind of library. The type varies with the purposes of the institution and the actual use to which the library is put. Some of the smaller institutions have a very small, yet adequate, collection of taxonomic manuals and reprints. Other stations have rather complete libraries on special subjects (*e.g.*, the bryological library of the Summer School of Bryology). A few stations have large libraries with bound volumes, reference books, reprints, and current serial publications on a number of biological subjects. Such collections require much equipment and the services of full-time librarians. The largest library operated by any biological station is that of the Marine Biological Laboratory. It ranks as one of the best libraries of scientific serial publications in the world.[5]

Itinerant Stations. — While not possessing fixed campuses or buildings, itinerant institutions nevertheless require the other necessary equipment for biological stations. Certain peculiar equipment of itinerant institutions include boats for the aquatic ones (*e.g.*, the ill-fated *Pourquoi Pas?*) and trucks, automobile caravans, and buses for the terrestrial ones (*e.g.*, Animal Ecology Field Trip of the University of Illinois). Cumbersome libraries and heavy apparatus are usually not maintained by these stations, although otherwise they possess the regular equipment necessary to care for the laboratory and living needs of their students, investigators, and faculty members.

...CHUSETTS (ca. 1925), *after an etching by R. L. Dickinson.*

References and Notes:— (1) New York Daily Tribune, July 9, 1873. — (2) U. S. Bur. Educ. Bull. 1910 (4) :1-360, 1910. — (3) *cf.* annual announcement of this institution for a detailed description of this vessel. — (4) Other vessels over 100 feet in length attached to biological stations include *De Lanessan* (Cauda, French Indo-China), *Mabahiss* (Alexandria, Egypt), *Africana* (Sea Point, Union of South Africa), *E. W. Scripps* (La Jolla, California). — (5) It contains 6,000 bound volumes, 52,000 bound serial publications, 1,300 current serial publications, and 130,000 reprints. *Cf.* FRANK R. LILLIE: The Woods Hole Marine Biological Laboratory. University of Chicago Press, pp. 100-05, 1944.

The Living Facilities at Biological Stations: — A majority of biological stations offer living facilities to their students, investigators, and staff members in addition to opportunities for research and instruction. Some of the early field stations did not concern themselves with the board and lodging needs of those in attendance, often because these were available in nearby towns. The Zoological Station of Naples, for example, has never made an attempt to provide living facilities, other than a noonday meal. As these institutions, however, began to be established in environments removed from centers of population, their managements were forced to provide living accommodations. From the inclusion of these facilities at some stations because of sheer necessity arose their inclusion at others because of saving both time and money of the students attending them. Also the value of maintaining living facilities was recognized as making for a closely-integrated scientific community[1]. For a physiologist to live in the same dormitory as a taxonomist was liberalizing. Equally broadening was the student's being able to eat at the same table with the faculty member.

From providing board and lodging, some stations soon extended their offerings to medical service and organized recreation. Today, therefore, a great many biological stations are prepared to offer those in attendance much more than a laboratory desk and a rowboat. That these facilities exist and often entail great administrative problems and expenses do not detract from the purpose of biological stations. Indeed, living facilities are furnished so that a student or investigator may better be able to fulfill the

purpose of the institution, may better be able to use that laboratory desk and rowboat.

Board. — Somewhat less than one-half of the field stations of the world offer boarding accommodations to those in attendance. This proportion often varies with the political area in which the station is located. Countries which have a high proportion of their stations offering dining accommodations include Japan, Canada, and the United States. Those countries which have a low proportion of their field stations offering boarding accommodations include Italy, Germany, France, and Sweden.

The equipment which these institutions require to prepare and serve meals varies both with the resources and needs of the stations and occasionally with the customs of the country in which they are located. The larger stations in the United States have separate dining buildings with mechanically-equipped kitchens. The itinerant field stations, on the other hand, have portable cooking apparatus. One of these stations (*i.e.*, West Virginia University Biological Expedition) has a kitchen on wheels.

The administration of the boarding facilities at these institutions is usually vested with the director of the station. In a few instances it is leased to a concessionnaire or, in small European stations, relegated to the *concierge* who is paid directly by the student or investigator. At several American stations board is offered on a coöperative basis: the students, investigators, and faculty members who receive board determine the policies of the commissary department.

Several biological stations offer equipment for students and investigators to prepare their own meals. In some instances, the students are expected to coöperate in preparing the meals. At other stations the students or investigators are expected to buy their own food and prepare it separately. The Marine Biological Station of Fouad I University in Egypt is unique in that the investigator shares in the services of a cook and houseboy (*farrash*), although he is expected to buy the unprepared food at a nearby canteen.

The biological stations which do not provide board or facilities for individuals to prepare their own are usually located within walking distance of places where meals can be obtained. Indeed, several American stations have established their headquarters in hotels where students are expected to obtain board.

Lodging. — About two-thirds of the biological stations of the world offer lodging accommodations. Almost all of the institutions which offer boarding facilities also offer lodging. In addition, one-fifth of the stations of the world which are not equipped to serve meals are equipped with sleeping arrangements. The countries which rank high in the proportion of field stations within their borders offering lodging facilities include Roumania, the Netherlands, Japan, Canada, United States, Sweden, and France. Those countries with a low proportion of their stations providing room include Algeria, Denmark, Italy, and Switzerland.

The equipment which these institutions require to lodge those in attendance varies both with the individual station and with the standard of living for the country in which it is located. In the United States, lodging accommodations range from the large dormitories of the Marine Biological Labo-

ratory with running hot and cold water in many rooms to the few supplies needed for the students to spend the nights in a sleeping bag at the Pacific Union College Field Nature School. Many of the stations in the United States maintain attractive cabins or sometimes tents for two or three persons each. In Europe, the lodging accommodations at most field stations are in the same buildings as the laboratory work, although at several stations (*e.g.*, Zoological Station of the Netherlands Zoological Society) special structures for lodging have been erected.

The maximum number of persons who can obtain lodging accommodations at a station ranges from 275 at the Marine Biological Laboratory to less than five (*e.g.*, Biological Station of Wijster). The biological stations which are prepared to care for the lodging needs of a large number of students and investigators include, in addition to the Marine Biological Laboratory, the Biological Station of the University of Michigan (with accommodations for 200 persons) and the Lake Itasca Forestry and Biological Station (with accommodations for 100).

The biological stations which do not provide lodging are usually located near places where it may be obtained. The Lake Geneva School of Natural Science, for example, is located on the grounds of College Camp, an enterprise which furnishes lodging and board. The Oceanographic Museum and Aquarium at Monaco, although offering no lodging facilities, is located near a number of *pensions* and hotels where the investigator may obtain rooms within a wide price range.

Cost of Living Accommodations. — The biological stations which offer both board and lodging usually charge one sum for both of these services. This amount varies for stations within a given country and for those in different countries. The highest cost is $28.00 a week for room and board (*i.e.*, Barro Colorado Island Biological Laboratory) and the lowest cost is the equivalent of $1.34 a week at the Marine Biological Station of the Tôhôku Imperial University in Japan. The average cost per week for board and lodging at fifty-eight stations is $9.00.

Those field stations which charge relatively high prices for board and lodging usually are, 1, in remote areas where food acceptable to foreigners is relatively costly (*e.g.*, $28.00 a week at the Barro Colorado Island Biological Laboratory in Panama); 2, in countries where the cost of living is normally high (*e.g.*, $15.21 a week at the Bermuda Biological Station for Research, Inc.); or 3, in countries with an unfavorable rate of exchange with the American dollar or British pound (*e.g.*, $16.85 a week at the Biological Station of Helgoland). In the United States, the reasons for the high costs of board and lodging at some stations are either their location in relatively remote areas (*e.g.*, $14.00 a week at the Science Summer Camp of the University of Wyoming) or their location in parts of the country where living costs are usually high (*e.g.*, $10.50 a week at the Biological Laboratory of the Long Island Biological Association).

Health and Recreation. — Community hygiene is only considered a factor of importance at those biological stations which have a large number of students and investigators in attendance. Most of the institutions outside the United States have shown no special regard for the health of their students or investigators, except in the case of tropical countries where this

is more essential. The greatest care for the health of students and investigators at any of these institutions has been taken at the Biological Station of the University of Michigan. Here a physician is in residence to provide medical service if the need should arise. He also supervises general camp sanitation. A one-room hospital is also available at this station for any person who may need temporary medical detention.

Many of the biological stations in the United States and a few of those in other parts of the world provide organized recreational facilities for persons in attendance. In most cases the recreation is in charge of the director, often assisted by staff members and students. Excursions, picnics, campfires, and dances are some of the recreational activities offered. One of the results of the organized recreational activities at biological stations has been the growth of a series of songs, either about life at the station or about the biological forms studied.

Another result of the announced recreational activities at biological stations (together with their location) is that some students, especially in the United States, attend these institutions as much for a vacation as for the instruction they will obtain. While the recreational activities at some stations do attract vacationists, those institutions which are sensitive to the recreational needs of students and investigators do not have the frequent problem of a general exodus of students from the station to a nearby town each week-end in search of amusement.

Note: — (1) An appreciation of the contribution of community life to the scientific program of the Marine Biological Laboratory is given by E. G. Conklin and Frank R. Lillie in the latter's The Woods Hole Marine Biological Laboratory. University of Chicago Press, pp. 170-76, 1944.

Instruction at Biological Stations: — One of the primary purposes for the operation of biological stations is the field instruction they offer. More than one-half of the contemporary field stations offer some kind of formal instruction in the biological sciences and related subjects to beginning and advanced students. A number of these institutions also conceive within the scope of their activity various kinds of public education, such as the maintenance of public aquariums and museums.

Those field stations which offer formal instruction are of two types: the so-called typical biological station which is equipped to offer both instruction and research, and the biological nature camp which is devoted almost wholly to instruction. In giving instruction, both kinds of institutions must solve certain problems attendant to the course work, in addition to those of equipment and living facilities. They must secure an adequate staff of instructors. They must evolve an educational philosophy to decide the course work to be given and the organization of the actual teaching. They must decide on the actual courses to be offered. They must solve a series of administrative problems related to curriculum practices, academic credit, tuition, and scholarships. Lastly, they must occasionally analyze the students they attract in order to compare the product of instruction with the aims of instruction.

The Teaching Faculty. — About 350 persons are engaged in teaching activities at the various biological stations each year. While some of these institutions have only one faculty member (*e.g.*, Summer School of Bry-

ology), the Marine Biological Laboratory has twenty-six. The average number of faculty members for those stations which do have formal instruction is between three and four.

Education, Academic Position, and Specialization. — Three out of four faculty members of biological stations in continental United States have their doctor's degree, and this figure is higher for those faculty members at the field stations of most other countries. A few stations have no faculty members with doctorates (*e.g.,* Lake Enemy Swim Biological Station), while the entire faculty of several of the larger field stations do have their doctor's degrees (*e.g.,* Scripps Institution of Oceanography).

The majority of faculty members are university professors, although their occupations during the period of the year in which the station is not in session vary from that of a retired high school teacher (*i.e.,* Dr. A. J. GROUT of the Summer School of Bryology) to a United States National Park Naturalist (*i.e.,* C. A. HARWELL of the Yosemite School of Field Natural History).

The majority of the faculty members of biological stations are zoologists. Among the fields of specialization other than general zoology, botany, and biology of the faculty members may be included oceanography, nature education, geology, meteorology, and astronomy.

Institutional Inbreeding and Faculty Turn-over. — During the regular academic year a large proportion of the faculty at biological stations is attached to the institution which sponsors the station. This is a type of institutional inbreeding. In the United States, this practice varies from one hundred per cent (*i.e.,* Oceanographic Laboratories of the University of Washington) to none, especially in those field stations which are autonomous and therefore do not have parent institutions. While it is often easier for a field station to employ faculty members attached to its sponsoring institution, a more qualified staff can often be obtained at least partially from outside institutions.

In order to prevent complete inbreeding of their faculty, several of the biological stations of the United States make a practice of employing instructors from outside institutions for one or several seasons. One station with eleven faculty positions has had seven of these filled by different persons in a space of four years. Another station (*i.e.,* Michigan State College School of Field Biology) with a faculty of three, has not had a change in its staff for a period of eleven years.

A frequent change of faculty members does not usually increase the quality of instruction, even though it may bring in a new point of view for a time. Some of the best instruction at these institutions is given by those persons who have taught at one station for many years, since most field instruction demands as much knowledge of the particular environment around the station as of the subject-matter itself. Yet while a slow faculty turn-over is a definite asset to the quality of instruction at many of these institutions, continuous teaching at any one station might retard the scientific progress of a particular instructor. This whole problem of faculty turnover is one which few stations have answered successfully. One method of solving this problem has been the granting of a periodic leave of absence to

the instructor and then keeping his position on the staff unfilled for the period he is absent from the station.

Teaching Load. — It is not easy to calculate the average teaching load of faculty members while in residence at biological stations because the teaching load is a function of the instructor's philosophy and method as well as of the actual number of students, courses, or credits for which he is held responsible. Of forty-nine United States stations, each faculty member in general is responsible for about seventeen students, although this varies from almost six students for each faculty member of the Marine Biological Laboratory to a theoretical number of sixty students for the one faculty member of the Laguna Beach Marine Laboratory.

The average number of courses each faculty member teaches is often a better criterion of teaching load than the average number of students, because course enrollments differ as widely within field stations as within colleges or universities. At the typical field station the instructor is responsible for teaching one course which, in the United States, averages between four and five academic credit hours of work. This figure varies from one-fifth of a course for each instructor (*i.e.,* New Hampshire Nature Camp) to three courses for the instructor (*i.e.,* Merriconn Biological Laboratory).

The average teaching load of most faculty members at field stations is such that they spend more than one-half of their time in teaching. The remainder of their time is spent in their own research or in supervising the investigations of advanced students. Most of the faculty members of American stations bring their wives and children with them to live at the station and they spend, therefore, a portion of their time with their families.

Educational Philosophy. — Once a biological field station has decided to offer formal instruction, it must next evolve an educational philosophy to determine the type of course work that it will give. Field stations have, in general, followed one of two educational philosophies, although the majority of stations offering formal instruction combine the two concepts as much as they are able.

One type of station has adhered to an educational philosophy of offering only advanced instruction, especially for persons preparing to receive advanced degrees or to become research investigators. While the Marine Biological Laboratory is perhaps the outstanding example of such an institution, at least twenty-five other stations adhere to this policy.

The opposite practice is that held by the biological stations which believe that field instruction should be of an elementary nature. This type of station, of which almost all are in the United States, offers only elementary courses for public school teachers and undergraduate students who have neither the desire nor the training for extreme specialization.

That both philosophies of instruction at biological stations have a legitimate appeal may be seen from the fact that more than one-half of the biological stations of the world which do offer instruction are prepared to give courses both to elementary and to advanced students. And in actual practice, the instruction at biological stations is not only determined by their educational philosophy, but also by their location, the instructors available, and the potential student-body.

Advanced Instruction. — The biological stations which offer only advanced course work are located from Finland to Algeria, from Maine to the southern part of California. The actual course-work offered by these institutions is often of a very advanced nature (*e.g.*, advanced invertebrate embryology at the Oceanographic Laboratories of the University of Washington), although several are intermediate courses and may be taken with only one previous course in the biological sciences (*e.g.*, entomology at the University of Michigan Biological Station). The biological stations which offer only advanced instruction may often be distinguished more by their admission requirements than by the courses they offer. Graduate and occasionally upper-class undergraduate students are admitted to these institutions. Yet even students of these ranks may take certain courses only after fulfilling certain prerequisites.

Elementary Instruction. — At least eighteen biological stations offer only elementary instruction. These institutions are, with the exception of the Helgoland Bird Observatory, located in the United States. The courses given at these institutions are usually in the fields of nature study and the pedagogical training of nature-study teachers. The requirements for admission to these institutions are minimal, for the purpose of instruction is generally to engender an appreciation and understanding of the outdoors by means of field trips and observations. Several institutions in this category are particularly interested in training special groups of persons, as teachers in nature study (*i.e.*, West Coast School of Nature Study) and leaders of nature recreation (*i.e.*, Virginia Natural History Institute Nature Leaders' Training Course).

Combined Instruction. — A majority of the biological stations which consider at least a portion of their function to be instruction offer course work to both advanced and elementary students. These institutions believe that both the beginning and advanced student may receive inspiration and instruction by being at the same biological station, if not actually attending the same courses. The actual courses at these stations vary from those of a very elementary nature (*e.g.*, man and the living world at the Isles of Shoals Marine Zoological Laboratory) to advanced ones with many hours of prerequisites (*e.g.*, parasitology at the Lake Itasca Forestry and Biological Station).

The requirements for admission to these biological stations which offer both elementary and advanced instruction are relatively flexible. In general, the requirements depend more upon the actual courses to be taken by the student, than by his general academic rank. Some of these stations (*e.g.*, Allegany School of Natural History) are open to "gifted high school students" and others (*e.g.*, Lake Itasca Forestry and Biological Station) are "open to all qualified graduate students who have had the usual preliminary courses in biological subjects." The purpose of the instruction given by institutions in this category also varies from fulfilling part of the science requirements of "pre-professional students, such as pre-medical, pre-dental" (*i.e.*, Isles of Shoals Marine Zoological Laboratory) to assisting "persons interested in the study, collection and determination of particular groups of animals and plants" (*i.e.*, Oregon Institute of Marine Biology).

The Courses. — About two hundred and fifty courses are given by those biological stations which offer some kind of formal instruction. Each institution offers an average of three courses a year, although the majority of stations give only one course. The American stations tend to offer more courses than those in other countries. One American station (*i.e.,* Lake Itasca Forestry and Biological Station), offers eighteen courses, while the largest number of courses given by a station located outside the United States is six (*i.e.,* Marine Biological Station of the Tôhôku Imperial University). Those stations offering only elementary instruction tend to give the fewest number of courses, while those which give only advanced instruction offer the greatest number of courses, perhaps because of the specialized needs and interests of advanced students.

Sciences Represented. — Most of the courses offered by biological stations are naturally in the biological sciences. While the largest number of courses are offered in zoology, the proportion varies from almost less than one-half for the stations in the United States to less than one-fifth for those institutions in other parts of the world. The inclusion of courses not within the traditional limits of zoology, botany, or biology indicates that these institutions fully realize the need of exploring, by instruction as well as research, the borderline fields between biology and the social sciences (*e.g.,* nature education) and biology and the physical sciences (*e.g.,* marine meteorology). Another need felt and realized at several stations is the integration of both the physical and biological sciences into one field course at an elementary level (*e.g.,* nature study).

A classified list of the general fields in which course-work is offered at one or more biological stations follows: protozoology, invertebrate zoology, helminthology, entomology, ichthyology, ornithology, vertebrate zoology, field zoology, animal ecology, economic zoology, parasitology, embryology, comparative anatomy, algology, mycology, bryology, taxonomy of higher plants, field botany, dendrology, plant ecology, plant physiology, plant anatomy, plant morphology, plant histology, limnology, marine biology, general ecology, general physiology, microbiology, wild life conservation, biochemistry, paleobiology, oceanography, nature study, nature education, geology, meteorology, chemistry, seismology, astronomy, and geography.

Types of Courses. — Instruction at biological stations probably first arose when college and university professors realized they could not teach successfully about marine life a hundred or thousand miles away from the sea. Instruction was first given at biological stations in subjects which could not be thoroughly or scientifically taught (*i.e.,* by observation and/or experimentation) in the ordinary college or university campus laboratory located often miles from a forest and even further from fairly uncontaminated seashore. Thus the first subjects to be taught at field stations were *1,* the taxonomy of biological forms, for the whole kingdom (*e.g.,* plant taxonomy), for a special area (*e.g.,* botany of the Alps), or for a special group (*e.g.,* bryology); and *2,* the ecology of biological forms, either for a whole kingdom (*e.g.,* animal ecology), or for special environments (*e.g.,* limnology).

As the research programs of biological stations became increasingly concerned with physiological problems, courses in physiology were given

at these institutions. At first these courses made good use of the living organisms in the field station environment. This departure, however, from the traditional type of course-work at field stations perhaps helped to lead to the initiation of a whole series of courses offered by these institutions which had less and less relation to the environment in which they were located. Courses such as cell morphology, experimental surgery, and histology-embryology appear in the catalogues of contemporary stations. Today students often go long distances to attend a field station which offers a course in a subject which may perhaps be better taught at a well-equipped university campus in the center of a large city.

There are several reasons for the introduction of these so-called "laboratory" courses at field stations. Some laboratory and lecture courses have been given frankly to attract a sufficient number of students to make the continuance of the station and especially of its field program possible. Such courses, for example, have often been for pre-medical students, the latter actually subsidizing the courses offered by the institution in the less popular "field" subjects. A second reason for the introduction of courses often unrelated to the station's biological environment is found in the station's research program. Several stations are avowedly more concerned with research than with instruction. The teaching they do offer is quite secondary and dependent upon both the station's research program and the staff members available as instructors. Thus the Biological Laboratory of the Long Island Biological Association offers a course in experimental endocrinology because it is one of the spheres of research upon which the laboratory has decided to concentrate; also, a member of this station's staff is perhaps more qualified to teach this subject than one more related to the environment in which the station is located. Other reasons for the offering of laboratory courses at field stations, in the words of station officials, are "we can get better work out of the student" and "there is a need for these courses and they are given nowhere else."

Another trend is the use, at some stations, of indoor laboratory methods even in field courses which may best perhaps be taught with so-called outdoor methods. Dr. CHARLES C. ADAMS once commented, "I have known of cases where the *field* school merely repeated the city class work, only using fresher material than in the city, and without the slightest idea that this was not a sane procedure"[1]. Such observations have caused some American biologists to believe that their students can often obtain better field instruction and experience from courses on several university campuses not too removed from "the field," than at some biological stations even in isolated places.

The Subject Matter.—While some courses offered by different biological stations may have the same titles, their subject matter often differs greatly. This divergence is most often due to the location of the station and to the training of the instructor, although the educational philosophy of both the station and instructor are important contributing factors. Because of their small classes, biological stations can be remarkably sensitive to the needs of their students. The courses given are often markedly altered once the instructor knows the wishes of the students actually registered in any course in a given year.

Administrative Problems. — The instruction at biological stations is most often organized into one, short session, beginning in June. Three-quarters of these institutions which give instruction offer it at only one session a year. Those stations which offer more than one session do so because of limited classroom facilities (*e.g.*, Zoological Station of the Netherlands Zoological Society), because of the desire to give instruction at different times of the year (*e.g.*, West Coast School of Nature Study), or in order to give instruction in different localities (*e.g.*, Oglebay Institute Nature Leaders Training School). The largest number of sessions is offered by the Audubon Nature Camp. This institution gives five two-week sessions each summer, the desire being to train a large number of students rather than to teach one-fifth the number five times as long.

The length of the sessions at biological stations ranges from one week to nine. Almost one-third of the sessions are two weeks in length, while about one-fifth are for a six-week period. The shortest sessions are usually conducted by nature camps, while the longest ones are at those stations offering only advanced instruction.

The time of the year when instruction is given at biological stations depends upon a number of factors, of which the flora and fauna, the students, and the faculty are most important. Instruction can only be given at those times of year when the desired animal and plant forms can be adequately studied in the field. Instruction in alpine botany, for example, can usually not begin before July in the Alps, whereas marine biology may best be studied along New England during August. The time of the year when students and faculty members are normally free from their regular college or university studies limits instruction at biological stations to the summer vacation in the northern hemisphere. The stations in France and England, however, have long made a practice of offering courses during the universities' Easter recess in April. This is a time which is fairly favorable for the study of marine biology in those countries in Europe and it is also during the student's term at the university — an advantage because the student can closely relate the field biology learned at the station to the laboratory biology studied at the university. The West Coast School of Nature Study is the only institution in the United States which has recently attempted to give a session during the Easter recess.

June and July is the period of the year during which the greatest number of sessions is given. October is the latest month in the year that a course is offered at any biological station (*i.e.*, at the height of the autumn bird migration season a course in ornithology is given at the Rossitten Bird Observatory).

Academic Credit. — In biology as well as in most other subjects, contemporary university students, especially in the United States, not only take courses for the knowledge they receive, but also for the credit they may obtain toward an academic degree. For this reason biological stations have found it expedient to offer college credit for formal course work completed by students at these institutions.

In the United States, about four-fifths of the biological stations offering instruction have made arrangements for students satisfactorily completing course work to obtain credit. Those field stations which are directly spon-

sored by colleges and universities have the privilege of granting credit because of their connection to these institutions of higher learning. Biological stations which are sponsored by institutions other than colleges or universities, or are only partially sponsored by them, often make arrangements whereby work done at them is recognized by some nearby or affiliated college or university and is thus transferable to other such institutions throughout the country. Some autonomous field stations use similar procedures to obtain credit for their students. Ten field stations in the United States do not offer academic credit. These range from institutions which offer instruction of a very advanced nature (*e.g.*, Marine Biological Laboratory) to those stations where the instruction is very elementary (*e.g.*, Green Mountain Nature Camp).

Tuition and Scholarships. — Students are assessed tuition fees at most biological stations. These fees are usually for instruction, and sometimes include scientific supplies and transportation on field trips. The average tuition at forty-six biological stations is the equivalent of $28.82. Tuition costs range from $1.00 at the Nature Enjoyment Camp to $75.00 at the Marine Biological Laboratory. This variation is due to a number of factors, the most evident of which is the length of the session. A base for comparing the tuition is, therefore, that charged students per week. This ranges from $.35 weekly at the Zoological Station of Tvärminne to $14.25 weekly at Science of the Out-of-Doors. The average weekly tuition is $5.73, the amount being $4.57 for the ten stations outside the United States about which information on the cost of tuition is stated.

At least fourteen biological stations regularly charge no tuition fees. More than four-fifths of these are outside the United States. A number of stations in the United States, however, offer tuition scholarships for students who desire a diminution of fees either because of their scholastic excellence or financial distress. These scholarships are either offered directly by the administration of the station or by organizations interested in the work that the station is doing (*e.g.*, two partial scholarships for students at the Allegany School of Nature History have been provided by the Burroughs-Audubon Nature Club of Rochester, New York).

The Student Body. — Instruction is given at biological stations for the benefit of students who take the formal course work. The type of instruction offered is determined by the educational policy of the institution. At a number of the smaller stations, however, it has been expedient to determine this policy only after considering the desires of the potential and actual student body of the station. This has necessitated a systematic estimation if not an actual survey of the students who are attracted to each station. Another use made of such an estimate is to ascertain to what degree the student body, as the product of instruction of a station, compares with the educational aims or assumptions of the institution.

The student body at most biological stations is characterized by its heterogeneity. The students at any biological station, as at many other types of educational institutions, may be found to vary in their sex[2] and age, in their race[3] and nationality[4], in their training and occupation, and in their institutional connections. Thus persons enrolled in course work at many

larger stations include college professors and high school seniors, women interested in becoming nature counsellors and men training for research in theoretical science.

Public Education. — *Aquariums.* — In the nineteenth century, public aquariums were often associated in the public mind with biological stations. Even today thirty-four of these institutions maintain public aquariums. Many of these were built during the nineteenth century. While this tradition of maintaining aquariums associated with biological stations is strong in many parts of the world, it is not so in the United States. Only two United States biological stations possess these displays (*i.e.*, Scripps Institution of Oceanography and the Fisheries Biological Station at Beaufort, North Carolina).

While those biological stations which do have public aquariums are naturally concerned with public education, many incorporate aquariums into their function as a means of subsidizing the research work of the station. This plan was first conceived by Dr. ANTON DOHRN and today the number of visitors (and thus fees) received by the larger aquariums is substantial. The annual number of visitors to the aquariums of several large stations is as follows: 180,000 at Monaco in 1938, 73,260 at Helgoland in 1937, 40,000 at Naples in 1937, 43,045 at Port Erin in 1938, and 32,000 at Plymouth in 1937. To supplement the observations of the public at these larger aquariums, elaborate manuals describing the biological forms exhibited are often issued.

Museums. — These institutions are also occasionally sponsored by biological stations for public education. Most are marine museums associated with marine aquariums. Other types include museums of systematic biology (*e.g.*, The George M. Gray Museum of the Marine Biological Laboratory) and outdoor field museums (*e.g.*, Outdoor Museum of the Allegany School of Natural History).

Botanical Gardens. — Especially in alpine regions, botanical gardens are operated in conjunction with biological stations. Eleven stations have such public botanical gardens. In addition to alpine gardens, there are tropical gardens (*e.g.*, Foreigner's Laboratory at Buitenzorg) and Indian gardens and nature trails (*i.e.*, Allegany School of Natural History).

Public Lectures. — Laboratory tours and public lectures are sometimes included among the public education features of biological stations. The Allegany School of Natural History, for example, scheduled a series of popular evening lectures once each week during the period that it was in session. This attracted a number of interested persons from the vicinity. Visiting days are also inaugurated at these institutions, both as educational features and to concentrate visits (and thus limit distractions) from the public to one day of each session.

Notes:— (1) From a letter, dated March 25, 1940, to the author. — (2) Although most biological stations today admit women students, co-education was a debatable subject when these institutions were first established. LOUIS AGASSIZ, however, had no misgivings about allowing women to register as students in the Anderson School of Natural History. He once stated, "As soon as the number of students was limited, we determined a question of no small moment,—whether ladies should be admitted. In my mind I had no hesitation from the start. There were those about us whose opinion I had to care for but did not know, so I thought the best way was not to ask it, but

to decide for myself." *Cf.* American Naturalist 32:189-96, 1898.— (3) Both colored and white persons are generally admitted as students and investigators at biological stations. The late Dr. ERNEST E. JUST, famous Negro biologist, spent many years at Woods Hole (*cf.* Science 95:10-11). The few biological stations located in the Southern United States do not admit Negroes. These stations feel they must follow the unjust mores of their region rather than lead in the *application* of scientific truth as they lead in the *investigation* of scientific truth.— (4) The student bodies of biological stations do not tend to be as international as the investigators at these institutions often are. The language barrier is one reason for this, since a person studying formally in a foreign country must be a better linguist than one doing research work. Another reason is that the course work at biological stations is generally duplicated at these institutions in many countries. There is not, therefore, the urgent need to cross national frontiers for course work as there is to do so in order to carry out investigations with rare forms or in unique environments. A third reason for the small proportion of foreign students at most biological stations, compared to the number of foreign investigators, is that most biologists have not attempted to excel as teachers. While an investigator might cross the ocean to work under the direction of a noted scientist, a person is less inclined to do so as a student, because there are fewer outstanding scientists with whom he may work at a biological station as a beginner. In certain instances, however, some foreign students may be found taking courses at biological stations. Systematic efforts should be made to facilitate the exchange of biological station students across international borders.

Research at Biological Stations: — Research is one of the primary functions of biological stations. Almost nine-tenths of these institutions offer research facilities. These are available to three types of persons: staff investigators, independent investigators, and student investigators. Several stations are prepared to accommodate all types, while others receive, for example, only independent investigators. Whatever the practices of the stations devoted to research, each type of investigator accommodated demands certain facilities from the station, while it in turn makes certain demands upon the investigator.

In addition to the living facilities and equipment offered to the different types of investigators, many biological stations attempt to furnish certain other opportunities to resident investigators and often also to research workers quite removed from the station. These include facilities for publication, supplies of biological specimens, and scientific symposia and conferences.

Research by Staff Investigators. — A portion of the research work done at almost nine-tenths of the biological stations is carried on by staff members of these institutions. The remaining stations either offer formal instruction exclusively, or are only prepared to offer facilities to visiting, independent investigators. The staff investigators who do pursue research problems are either permanent or part-time members, the latter often also giving formal instruction or supervising student research at the station.

Almost one-half of the biological stations maintain a permanent research staff. This practice varies with the customs of the countries in which these institutions are located. All of the Russian stations, for example, have a permanent staff, while none of the Algerian stations do. The larger countries with a high proportion of the field stations maintaining a permanent staff include Italy, Spain, Germany, and England. Those countries with a low proportion of stations with a permanent research staff have a complementary high proportion of stations with part-time staff investigators.

Permanent Staff and Program. — More than one hundred biological stations have a permanent, year-round staff. The actual number of staff members at these institutions varies from fifteen (*i.e.*, Scripps Institution

of Oceanography) to one (*e.g.*, Danish Arctic Station). The staff of more than one-half of these stations is composed of only one or two members. Only seventeen stations have five or more members of their permanent research staff. In addition, most of the larger stations have a number of full-time laboratory technicians, assistants, and administrative employees (especially librarians) who all aid in the research output of the institution.

The field stations which do have permanent staffs either do research on general biological problems or, due to sponsorship or location, concentrate their work in certain fields. Almost one-third of the stations specialize in research in marine biology. Other major fields of specialization at these institutions include fresh-water biology, fisheries, and oceanography.

Research institutions, especially in the more theoretical sciences, have often failed to bring about the coordination of personnel to the degree which some think to be necessary to make for the greatest efficiency in research. While this is often due to limited funds and equipment, it is perhaps equally due to lack of tradition for a type of teamwork in theoretical science that is comparable to that accomplished by the more practical scientific research institutions. At most biological stations with a permanent staff, the investigators — although staff members — work quite independently and their problems have little relation with each other. At a few biological stations, however, and especially at those dealing at least in part with applied biology, there is more of a closely correlated research program. There are evidences, too, that this coordination is slowly spreading to more biological station research programs.

The actual research programs of biological stations are too diverse for adequate generalization.[1] It may be said perhaps that these programs have attempted to keep abreast of the general trends in biological research, although some have lagged behind while others have pioneered for the science as a whole.

Part-time Staff and Program. — More than one hundred biological stations have a part-time staff of investigators. These persons are usually expected to do research during the period of the year that they are attached to the station or to do as much research as they are able after giving formal instruction or supervising student research at the station. The number of staff members of these institutions varies from twenty-two persons (*i.e.*, Marine Biological Laboratory) to one (*e.g.*, Royal Hydrobiological Station of Lake Trasimeno). Almost two-thirds of these stations have only one or two investigators, and the average part-time staff consists of three members. Twelve stations have five or more staff members, and ten of these are located in the United States. In addition to staff investigators, these institutions also employ part-time laboratory assistants and technicians to aid the investigators with the more routine laboratory and field tasks.

The biological stations with part-time investigators have less of a specialized research program than even those institutions with permanent staffs. The specialization of almost one-half of these biological stations with part-time staffs is due to its location either on fresh bodies of water or on the sea, while an additional one-third of these institutions pursue a research program in general biology. A few of these stations center their researches around such special fields as botany, ecology, or fisheries.

If the research program at those biological stations with a permanent staff is often uncoordinated, that at the institutions with a part-time staff is generally more so. Frequently the part-time investigator, although invited to undertake research work at the station, is also expected to supervise student research and give formal instruction. In such cases, whatever research the investigator does is secondary to any research program the station may have. The part-time staff member becomes, in reality, an independent investigator whose laboratory and often living fees are met by the station. The result is that the investigator spends his time completing previous research or inaugurating a project of his own interest which is often unrelated to that of his colleagues at the field station. A few of the institutions with part-time investigators do, however, have a well-correlated research program. This is due either to the part-time staff spending its full time in research or, less frequently, the retention of the same investigator year after year — a procedure not commonly adopted by most stations.

While stations in this category are characterized as institutions with a part-time staff, this does not necessarily mean that they are closed for a portion of the year. About one-quarter of these institutions are open throughout the year. Such stations may be open to staff investigators on a twelve-month basis, but the investigators are only hired on a part-time arrangement.

Research by Independent Investigators. — More than nine out of ten biological stations offer research facilities to independent investigators. Of the institutions which do not, a majority are biological nature camps which are concerned usually with elementary instruction. A few institutions do not admit visiting investigators because their limited budget can accommodate only members of their permanent staff (*e.g.,* Pacific Biological Station) or because the station is in the process of organization and has no facilities to offer visiting investigators (*e.g.,* Rocky Mountain Biological Station of the University of Michigan).

The biological stations which offer facilities to visiting investigators have various conditions for their admittance. Some institutions admit investigators in any biological subject quite unreservedly and with few formalities. Other stations carefully review the qualifications and proposed research program of the applicant and then he or she is admitted only if the research project coincides with the general aims of the station. In general, all stations at least want to know the problem the investigator will pursue and the time of his arrival, so they can better prepare for his investigations.

After the independent investigator is admitted to a biological station, he may or may not be assessed laboratory fees. More than one-half of the biological stations do not charge fees. About one-fifth of the institutions have laboratory fees which range from five to fifteen dollars a month, while another one-fifth charge monthly fees equivalent to more than fifteen dollars. The most expensive fee is one hundred dollars a month (*i.e.,* Mount Evans Laboratory).

A method whereby a field station obtains income from the facilities it offers, yet not from the individual investigator, is the so-called table system. This is believed to have been inaugurated by the Zoological Station of Naples. It has been adopted, with some alterations, by other institutions[2].

As the laboratory fees or table arrangements differ, so do the facilities which biological stations put at the disposal of the visiting investigators. Some of the smaller stations permit the investigators to use whatever equipment is available. Others attempt to give the research workers as much complicated apparatus and as many special solutions as the institution can afford. In addition, stations often supply the investigators with fresh animal and plant forms daily, if required. The facilities offered to investigators and the procedures by which they may be obtained are often codified in the form of laboratory rules.

In addition to laboratory facilities, visiting investigators are often given certain concessions by virtue of their connections with some biological stations. Occasionally they are privileged to bring scientific apparatus into the country in which the station is located duty free (*e.g.*, Zoological Station of Naples). Some stations obtain reduced transportation rates for research workers (*e.g.*, Bermuda Biological Station for Research, Inc.). Other stations which are not able to provide full living facilities to investigators also may obtain reductions in living costs at nearby hotels or restaurants for them (*e.g.*, Jungfraujoch Scientific Station).

In furnishing laboratory facilities to independent investigators, biological stations do so with the implied agreement that the worker will do his best to contribute to the progress of science. Most stations ask no more of the investigator. Some of these institutions, however, expect that the investigator will partially repay the station in one of several tangible ways. These include identifying animal and plant forms, acknowledging indebtedness to the station in printed reports of any work done at the station, compiling a separate report of research undertaken, and donating reprints of any published research to the station library.

The number of investigators who take advantage of the facilities offered by biological stations varies with the time of the year and — over longer periods of time — with economic and international conditions. About three-quarters of the stations which offer facilities to investigators of this type are open throughout the year. As only a few independent investigators are on year-round fellowships or sabbatical leaves of absence, the summer months or short periods at Easter recess are the only time that the majority of research workers are able to make use of these facilities. As a rule, therefore, many of these stations are crowded in the summer months and — if open at all — are quite empty in winter.

The maximum number of investigators which these institutions can accommodate at any one time varies from two (*e.g.*, Marine Laboratory of the University of Sydney) to more than 250 (*i.e.*, Marine Biological Laboratory). More than two-thirds of these institutions accommodate no more than ten visiting investigators. Those stations which have facilities for more than twenty-five independent investigators include the institutions at Bermuda, Salisbury Cove (Maine), Plymouth, Villefranche, Helgoland, Naples, and Woods Hole (Marine Biological Laboratory).

The actual research work done by the independent investigator at biological stations is often in the field. There are instances, however, where the investigations are carried on exclusively in the laboratory, often with such forms as rabbits and mice. The investigations may be in a phase of theoretical biology or in one of the applied or border-line fields. Some are

life-time problems and others are projects which may be completed in a few weeks.

Research by Advanced Students. — Almost one-half of the biological stations are known to be equipped to receive advanced students who desire to do research work under direction. These institutions are, for the most part, stations which offer formal instruction, although in some instances stations devoted exclusively to research provide for the training of research investigators (*e.g.*, Woods Hole Oceanographic Institution). The supervisors of student research are usually faculty members also offering more formal class-work, although they may be permanent or part-time staff investigators who are qualified to direct research by their academic affiliation or attainment.

The conditions under which students are admitted to do research under direction vary considerably. A few stations allow undergraduate students to undertake research (*e.g.*, the Bowdoin Scientific Station is organized primarily for this purpose). Most field stations, however, offer such facilities only to graduate students who are working for a higher degree. Admission requirements in such cases usually coincide with those of the institutions which grant the degree.

Since the research work done at biological stations is often under the official direction of the institution which awards the advanced degree, the fees for such supervision of student research are controlled usually by the university concerned. These do not, however, differ greatly from those charged students taking formal course work. A number of student investigators are subsidized in their studies by fellowships and scholarships granted by the universities to which they are attached. In addition, several biological stations offer special fellowships to advanced student investigators.

The actual research done under supervision at biological stations includes field and laboratory work in many branches of biology. Many of the problems are of a relatively limited scope, often being connected with the larger work or interest of the supervising faculty member. Some of this research is written up as theses in partial fulfillment for advanced university degrees. In other instances, the studies are preliminary.

Facilities for Publication. — Biological stations occasionally offer staff and independent investigators opportunities for the publication of the results of their researches. These facilities are in the form of serial publications issued by the field station. A few of these serials are published bi-monthly (*e.g.*, *Biological Bulletin* of the Marine Biological Laboratory), while others are issued annually (*e.g.*, *Bulletin of the Mount Desert Island Biological Laboratory*). A number are issued only occasionally (*e.g.*, *Fauna et Flora Laurentianae* of the St. Lawrence Biological Station).

The material in these publications of biological stations is generally limited to reports of research undertaken at the station (*e.g.*, *Palao Tropical Biological Studies*), although sometimes they include papers reporting investigations conducted elsewhere (*e.g.*, *Der Vogelzug* of the Rossitten Bird Observatory). While most of the material in these serials is the result of scientific work, space is devoted in some of these publications to reports of the general work and financial condition of these institutions (*e.g.*, *Annual*

Report of the Freshwater Biological Association of the British Empire). The larger stations are able to separate the types of articles included in these publications by issuing several kinds of serials (*e.g., Thalassia* and *Note* of the Italian-German Institute of Marine Biology).

The oldest serial publication issued by any biological station is believed to be the *Fauna et Flora del Golfo di Napoli.* This was first published by the Zoological Station of Naples in 1880. The most recent serial bulletin to be established by a biological station is the *Publication of the Marine Biological Station, Ghardaqa* (1939). Several well-known publications of biological stations have been compelled, for one or more reasons, to discontinue or at least merge with other journals. These include *Mittheilungen aus der Zoologischen Station zu Neapel* (which became *Pubblicazioni della Stazione Zoologica* after its twenty-second volume), *Travaux du Laboratoire de Zoologie et Physiologie maritime à Concarneau* (which was discontinued during the first World War), and *Wissenschaftliche Meeresuntersuchungen, Abth. Helgoland* (which since June 1937 has been *Helgoländer Wissenschaftliche Meeresuntersuchungen*).

In addition to providing publication facilities to research investigators, biological stations are able to use these serials to obtain similar journals from other scientific institutions by means of exchanges. Those stations which do not publish serials occasionally issue a limited edition of collected reprints of published research work done at the station (*e.g., Collected Reprints* of the Woods Hole Oceanographic Institution). These, too, are frequently used for exchange purposes.

The research papers of investigators at the biological stations which do not publish scientific serials usually appear in the appropriate journals of other scientific institutions or organizations. In some instances, certain journals quite independent of the biological station often receive most of the research papers originating from that station. Thus many articles describing the results of research undertaken at the Zoological Station of Algiers appear in *Bulletin de la Société d'Histoire Naturelle Afrique du Nord.* Often an institution sponsoring a biological station publishes the research work of that station in its scientific publications. Thus many of the researches completed at the Allegany School of Natural History have appeared in the various publications of the New York State Museum which, for some years, was a co-sponsor of that station.

The Supply of Biological Specimens. — A method by which biological stations contribute to research and instruction is the collection and sale of preserved and living biological specimens. Some biological stations were organized because biologists for their research and instructional needs were unable to obtain necessary biological forms. Laboratories were therefore set up where these could be more easily obtained. Now some of these very same laboratories are making it possible for biologists to receive living and preserved specimens many hundreds of miles away from the natural environment of these forms.

At least twelve biological stations have well-organized biological supply departments. These include the stations located at Amoy, Plymouth, Wray Castle, Helgoland, Krefeld, Ennur, Naples, Rovigno, Helder, Portobello, Millport, and Woods Hole (Marine Biological Laboratory). Some of these

departments do a relatively small annual business, although that of the Marine Biological Laboratory had a gross income of almost $40,000 in 1938. Most of these supply departments issue some kind of price-list for prospective individual and institutional purchasers.

The disadvantage of this auxiliary service of a biological station is that many of the materials must be collected in the immediate neighborhood of the laboratory. The type of wholesale collecting which it is necessary for most supply departments to do often negates the advantages, both financial and scientific, of operating this service.

Scientific Lectures and Conferences. — A method used by a few of the larger biological stations to promote the advancement of science in general is the sponsoring of scientific lectures and conferences. Some stations schedule a series of scientific lectures to be delivered at the station by staff members, visiting investigators, or special lecturers. These talks are sometimes about subjects of general biological interest, while at other times they are on very specialized topics. In both cases, they result in a broadening of the knowledge and interests of those research investigators attending them. Often information on the results of unpublished scientific experiments and observations are divulged for the first time at these talks.

Biological stations are occasionally hosts to various biological symposia, conventions, and congresses. The Symposia on Quantitative Biology of the Biological Laboratory of the Long Island Biological Association are perhaps the most noted of such conferences to be sponsored by field stations in recent years. While this symposium has been inaugurated by the station and is an annual event, others are organized by independent scientific organizations and convene at the biological station for only a single occasion. When the Fourth Pacific Science Congress met in Java in 1929, the Visitors' Laboratory at Buitenzorg was host to many visiting botanists. In North America, the Genetics Society has held summer meetings at the Marine Biological Laboratory for several years. Such conferences at biological stations often introduce students and investigators to the visiting scientists and they, in turn, are introduced to the work and potentialities of the station.

Notes: — (1) A splendid account of the research program for the first twenty years at one station is given by FRANK R. LILLIE: The Woods Hole Marine Biological Laboratory. University of Chicago Press, pp. 115-56, 1944. — (2) These table systems have helped to make possible the international exchange of investigators at biological stations. Few systematic attempts have been made in peacetime to overcome the normal difficulties of foreign research and thus facilitate the interchange of investigators.

* * * * *

The following directory brings together information on 271 biological stations in fifty-nine political areas. The description of each station has been necessarily limited to fit within the format of this study. An attempt is made, however, to give at least the following enduring facts about each station: the location, the name, the sponsoring organization, the purpose, the unique equipment, and the name of its scientific publications. Less often information is given on the biological surroundings of the station, the date of foundation, and the time of year the station usually has been open (if

normally closed for a portion of the year). Occasionally less permanent but often indicative information is given, such as the annual budget, the name of the director, the number of resident scientific investigators, the type and size of boats, and a description of the course work offered. No attempt is made to give the most recent information available on the names of staff members, the number of menial employees, the size of the library, the cost of board and lodging, the maximum number of students accommodated, tuition costs, and the fees assessed independent investigators.

An attempt is also made to give for most stations a fairly complete listing of existing bibliographic references to descriptions of them and their facilities. Space has not been sufficient to give the titles, authors, and dates of these articles, but for convenience the references are listed in chronological order (the first given being the oldest). Perhaps the most consistently useful descriptions of many of these institutions are found in the previous, older catalogues of biological stations. These have been abbreviated in this directory as follows:

Chronica Botanica....Chronica Botanica Co. Leyden, Zuid-Holland and Waltham, Massachusetts. Vol. I (1935) *seq.*

DEAN 1894....DEAN, BASHFORD. Notes on marine laboratories of Europe. Report of the Smithsonian Institution for 1893:505-19, 1894.

JUDAY 1910....JUDAY, CHANCEY. Some European biological stations. Transactions of the Wisconsin Academy of Sciences, Arts, and Letters 16:1257-77, 1910.

KOFOID 1910....KOFOID, CHARLES ATWOOD. The biological stations of Europe. United States Bureau of Education Bulletin 1910(4):1-360, 55 pls., 48 figs. 1910.

LENZ 1927....LENZ, F. Limnologische Laboratorien. Handbuch der Biologischen Arbeitsmethoden 9, 2(1):1285-1368, 1927.

MAGRINI 1927....MAGRINI, G. Instituts et laboratoires s'occupant de l'étude de la mer. Conseil International de Recherches, Union Géodésique et Géophysique Internationale, Section d'Océanographie, Bulletin 7:1-115, 1927.

RICKER 1937....RICKER, W. E. Glimpses at fishery biology and fish culture in Europe. Progressive Fish Culturist 31:29-33; *Ibid.* 32:12-15; *Ibid.* 34:12-14, 1937.

SAND 1898....SAND, RENÉ. Les laboratoires maritimes de zoologie. Revue de l'Université de Bruxelles 3:23-47, 121-51, 203-35, 1898.

SCOURFIELD 1905....SCOURFIELD, D. J. Fresh-water biological stations. Jour. Quekett Micro. Club II, 9(56):129-36, 1905.

Turtox....General Biological Supply House. Biological field work. 1928-32, 1934, 1935, 1937. Chicago, Illinois.

VAUGHAN 1934....VAUGHAN, T. W. Catalogue of marine stations of the Pacific. International Commission on the Oceanography of the Pacific, Report of the Chairman. Fifth Pacific Science Congress Proceedings 1:361-80, 1934.

VAUGHAN 1937....VAUGHAN, T. W. Catalogue of institutions engaged in oceanographic work. In International aspects of oceanography. (T. W. VAUGHAN and others.) 225 pp. Washington: National Academy of Sciences. 1937, pp. 73-225.

DIRECTORY *of* BIOLOGICAL STATIONS

It must be re-emphasized that, with few exceptions, the descriptive accounts given here are corrected to 1940—before World War II became world-wide. As the war progressed, many of these institutions curtailed their activity and some even suspended operation. Despite these changes wrought by the war, it has been thought useful for biologists and others to have a picture of these institutions at perhaps the peak of their operation (1939-40)*.

—*ALASKA*—

Little Port Walter (Baranof Island): **Field Laboratory of the United States Fish and Wildlife Service:** — About 18 miles from the open ocean, with one stream flowing into the bay and that originating in a series of mountain lakes. Established in 1941 by the U.S. Fish and Wildlife Service for the study of the natural reproduction of pink salmon. Laboratory and living facilities are available for visiting biologists. — *Cf.* Science 94:295.

—*ALGERIA*—

Algiers: **Station Zoologique d'Alger:** — Founded in 1888, this institution is conducted by the Faculty of Sciences of the University of Algiers. There is a two-story laboratory building. — *Cf.* La Nature 16(2):327-30; SAND 1898; VAUGHAN 1937.

Beni Ounif: **Laboratoire de Biologie Saharienne:** — Situated in a stony desert near a date palm oasis and ten miles from the mountains of Morocco. Founded in 1930 and attached to the Faculty of Sciences of the University of Algiers. The building contains four laboratories and a herbarium. — *Cf.* Chronica Botanica 1938.

Maison-Carrée: **Station Botanique de Maison-Carrée.**

—*ARGENTINA*—

Quenquén: **Estacion de Biología Marina del Museo Argentino de Ciencias Naturales de Buenos Aires.**

—*AUSTRALIA*—

Cronulla (New South Wales): **Commonwealth Fishery Research Laboratories:** — Sponsored by the Council for Scientific and Industrial Research of the Commonwealth of Australia. There are two large, well-equipped laboratory buildings. Two-ton truck available as a mobile laboratory for coastal work. Several large boats available, including 82-foot, 138-ton M. V. Warreen. — *Cf.* Nature 144:312-13; VAUGHAN 1937.

Narrabeen (New South Wales): **Biological Field Station of the Sydney University Biological Society:** — Founded in 1934 and sponsored by the Sydney University Biological Society. In a suburb of Sydney, where there are laboratory and living accommodations. — *Cf.* Nature 134:602, 623; Chronica Botanica 1:81; *Ibid.* 2:73.

Port Jackson (New South Wales): **Marine Laboratory of the University of Sydney:** — Situated in Sydney harbor and equipped for research and instruction in marine biology and oceanography. Sponsored by the Department of Zoology of the

---

* Beyond the scope of this directory are accounts of the numerous biological stations of the past (*cf. supra,* p. 10-11). — Dr. VERDOORN has expressed his willingness to publish a historical account of these stations. Much material concerning them may be found in my manuscript thesis (*cf. supra,* p. 5). In the CHRONICA BOTANICA ARCHIVES there is a file of several thousand cards dealing with the history of botanical gardens, museums, etc. This includes quite some data concerning early biological stations (*cf.* CHRONICA BOTANICA 8:445).

University of Sydney with funds contributed also by the Australian Research Council and the Commonwealth Council for Scientific and Industrial Research. 13-ton auxiliary yacht with oceanographical apparatus available. — *Cf.* Science 74:202; VAUGHAN 1934; VAUGHAN 1937.

— BELGIUM —

Ostend: **Institut Maritime de Belgique:** — Founded in 1900, reorganized in 1935 and now connected with the Royal Museum of Natural History of Brussels. — Research published in Annales de l'Institut Maritime de Belgique. — *Cf.* VAUGHAN 1937.

Rouge-Cloître (Brabant): **Laboratoire de Biologie Lacustre.**

Sourbrodt: **Station Scientifique des Fagnes:** — Located in the bogs of the Belgian Ardennes at an altitude of 2,211 feet. Founded in 1928 by the University of Liège and under the supervision of Professor RAY. BOUILLENNE. The station is open normally from June to October and both laboratory and living accommodations are available. — *Cf.* Bull. Soc. Roy. Bot. Belg. 58:20-24; Chronica Botanica 1:93; *Ibid.* 2:85.

— BERMUDA —

St. George's: **Bermuda Biological Station for Research, Inc.:** — Founded in 1903 at Flatts, Bermuda and moved to present location in 1932. Sponsored to offer facilities for research in biology and oceanography in the Bermuda region by an international board of trustees on which are representatives from Bermuda, England, Canada, and the United States. The 12-acre plant includes complete laboratory and living facilities. Oceanographic research vessel, Culver, attached to the station, as is a 24-foot launch. Investigators may obtain reduced steamship rates and exemption from paying customs on their scientific supplies and equipment. — *Station publications:* report of the officers; contributions, Bermuda Biological Station for Research, Inc. (1931-); and Collected Reprints, Bermuda Biological Station for Research, Inc. — *Cf.* Chambers Jour. 6(7):783-84; Pop. Sc. 66:393-411, 556-72; Science 65:128-30; *Ibid.* 73:488-89; *Ibid.* 75:133-36; Nature 139:948-51; Science 89:28; *Ibid.* 94:319; Chronica Botanica 1935; *Ibid.* 1936; *Ibid.* 1938; Turtox 1937; VAUGHAN 1937.

— BRAZIL —

Alto da Serra: **Estação Biológica do Depto. de Botánica do Estado:** — Near São Paulo at an altitude of 2,400 feet in a virgin sanctuary for native animals and plants. Founded in 1909 and now supervised by Professor F. C. HOEHNE. — *Cf.* Ber. Deutsch. Bot. Ges. 50:154-64; Scientific Monthly 25:5-8; Chronica Botanica 1935; *Ibid.* 1936.

Itatiaia (Rio de Janeiro): **National Park and Biological Laboratory.**

— BULGARIA —

Varna: **Biological Station and Aquarium:** — Situated on the Black Sea near a rocky and sandy shallow-water zone which is rich in animal and plant life and thus equipped for research and instruction in marine biology. Begun in 1906 but not opened until 1932 and now sponsored by the University of Sofia. There is a 3-story laboratory building which contains a public aquarium, research laboratories, dormitories, and a library. Courses are offered in hydrobiology and natural history for teachers. — *Station publication:* Arbeiten aus der Biologischen Meeres-station am Schwarzen Meer. — *Cf.* Int. Rev. Hydrobiol. 1:745-46; *Ibid.* 29:157-58; JUDAY 1910; KOFOID 1910.

— CANADA —

Algonquin Park (Ontario): **Ontario Fisheries Research Laboratory:**—Sponsored by the University of Toronto for research of fisheries resources. Founded in 1919-20, the laboratory was moved to present site in 1936 and now is under the direction of Professor WILLIAM J. K. HARKNESS. Laboratory and living accommodations are available. — *Station publication:* University of Toronto Studies, Biological Series. Publications of the Ontario Fisheries Research Laboratory (1922-).

Kent Island (New Brunswick): **Bowdoin Scientific Station:** — Founded in 1935 by WILLIAM A. O. GROSS of Bowdoin College (U.S.A.) to inspire research in biology and meteorology by undergraduates. Six, well-equipped buildings are available for

research from June fifteenth to September fifteenth. — *Station publications:* Contributions from the Bowdoin Scientific Station (1938-); and annual report (mimeographed). — *Cf.* Natural History 37:195-210.

Nanaimo (British Columbia): **Pacific Biological Station:** — Sponsored by the Fisheries Research Board of Canada for scientific investigation of marine and fresh-water problems. Dr. W. A. CLEMENS directs the large plant, which includes many well-equipped laboratories, museum, library, dormitory, kitchen, and staff offices. A 60-foot boat is available for oceanographical investigations. — *Cf.* Proceedings and Transactions of the Royal Society of Canada 3(2):lxxiii-lxxiv; Fifth Pacific Science Congress 1:200; MAGRINI 1927; Turtox 1937; VAUGHAN 1934; VAUGHAN 1937.

St. Andrews (New Brunswick): **Atlantic Biological Station:** — Sponsored by the Fisheries Research Board of Canada to provide facilities for research on fresh and salt-water fisheries. It is on the shore of a deep, tidal estuary of the St. Croix River. There are several laboratory buildings, experimental aquarium tanks and pools, a 90-foot diesel-engine research vessel, Zoarces, and a 28-foot vessel, Delphine. — *Cf.* Proceedings and Transactions of the Royal Society of Canada 2(4):xiii; *Ibid.* 2(5):xxi-xxii; *Ibid.* 2(6)xiii-xv; MAGRINI 1927; Turtox 1937; VAUGHAN 1937. Bot. Gaz. 27:79.

Trois-Pistoles (Province of Quebec): **Station Biologique du St.-Laurent:** — Located on the south shore of an estuary of the St. Lawrence River for the purpose of studying the hydrography, flora, and fauna of the region. Founded in 1931 by Laval University and now sponsored by this institution. Professor ALEXANDRE VACHON directs the work of this station which consists of a 2-story laboratory building and the 50-foot boat, Laval. — *Station publications:* Rapports annuels (1932-); Contributions de la Station Biologique du Saint Laurent (1932-); Fauna et Flora Laurentianae (1936-). — *Cf.* VAUGHAN 1937.

— *CAROLINE ISLANDS* —

Korror Island: **Palao Tropical Biological Station:** — Sponsored by the Japanese Society for the Promotion of Scientific Research for research in the biology of coral reefs. Professor S. HATAI is the director of the station which is housed in a one-story building. — *Station publication:* The Palao Tropical Biological Studies. — *Cf.* Nature 140:735; VAUGHAN 1937.

— *CEYLON* —

Colombo: **Fisheries Research Station.**
Peradeniya: **Visitors' Lab. of the R. Botanic Garden.**

— *CHILE* —

Corral: **Estación de Oceanografía.**

— *CHINA* —

Amoy (Fukien Province): **Amoy Marine Biological Station:** — (This station has moved inland to Tingchow for the duration.) Founded in 1934 to promote the study of marine biology by the University of Amoy. Professor T. Y. CHEN is director of the station which offers a course in marine biology during the summer months. — *Station publications:* Amoy Marine Biological Bulletin; Annual Report of the Amoy Marine Biological Station (in Chinese). — *Cf.* Science 72:429-30; VAUGHAN 1934; VAUGHAN 1937.

Sen-Kia-Men (Chusan Islands, Chekiang); **Tinghai Marine Station:** — Founded in 1936 for biological and oceanographic research and later sponsored by the National Research Institute of Biology. — *Cf.* VAUGHAN 1934; VAUGHAN 1937.

Tsingtao (Shantung): **Tsingtao Marine Biological Station:** — Sponsored by the Academia Sinica and several other societies. The building was started and almost completed in July 1937, when the war started.

— *CUBA* —

Habana: **Institute for Marine Biology:** — The establishment of a new institute of marine biology has recently been authorized by the Dept. of Agriculture of the Govt. of Cuba. It is being located at Castillo de la Punta. The institute will include a library, a museum, a div. of "industrial experimentation", etc.

Soledad: **Atkins Institution of the Arnold Arboretum:** — Founded in 1898 by EDWIN F. ATKINS, and now sponsored by Harvard University for tropical research in botany and zoology. Professor THOMAS BARBOUR directs the work of the station which is housed in one well-equipped laboratory building. There are separate living quarters and a 200-acre botanical garden devoted to the cultivation of economic plants. There are accommodations for six investigators at one time. — *Cf.* Science 59:433-34; Jour. of Heredity 15:451-61; Bul. Pan-American Union 70:631-38; Sci. Mon. 51:140-46; Science 94:534.

— *CZECHOSLOVAKIA** —

Blatná: **Station für Hydrobiologie und Fischzucht an den Lnáreteichen:** — Cf. LENZ 1927; Chronica Botanica 1936.

Hirschberg [Doksy] (Böhmen): **Station Hirschberg a. See der Reichsanstalt für Fischerei:** — Founded in 1905 by Dr. VIKTOR LANGHANS for hydrobiological research. Dr. TRUDE SCHREITER directs the work of the station which is housed in a 3-story building. — *Cf.* Verein der Naturfreunde in Reichenberg 60:46-49; KOFOID 1910; LENZ 1927.

Krtiny (Moravia): **Biologická Stanice Céskych Vysokychškol Brněnských:**—Sponsored by the Czechoslovakian Academy of Sciences and the Ministry of Education for research in general biology in a region of hilly lands and ponds. — *Cf.* LENZ 1927; Chronica Botanica 1935.

Samorin (near Bratislava): **Biologická Stanice Komenského University:** — Cf. Chronica Botanica 1936.

Strbské Pleso (Vysoké Tatry): **Geobotanical Station of the Czechoslovakian Botanical Society:** — Founded in 1931 and now sponsored by the Czechoslovakian Botanical Society for research in botany, ecology, and phyto-sociology. Station open to investigators from May first to November first.

Velké Meziříčí (Mähren): **Die Franz Harrach'sche Station für Fischerei und Hydrobiologie:** — Founded in 1928 by FRANZ HARRACH and now an independent institution. There is one, well-equipped building.

— *DENMARK* —

Charlottenlund Slot (Copenhagen): **Dansk Biologisk Station:** — Situated on the narrow sound separating Denmark from Sweden south of the Kattegat, with a fresh-water annex at Frederiksdal. Sponsored by the Danish Ministry of Agriculture and Fisheries for investigations on marine and fresh-water problems. Dr. H. BLEGVAD directs the work of the station, which has a budget of 140,000 Kroner. Laboratory headquarters are in Charlottenlund Castle. 143-ton research steamer, Biologen, available for research problems between April first and October twentieth. — *Station publication:* Report of the Danish Biological Station (1890-91-). — *Cf.* Revue Générale des Sciences 47:623-30; SAND 1898; KOFOID 1910; MAGRINI 1927; VAUGHAN 1937; RICKER 1937.

Frederikshavn: **Universitetets Havbiologiske Laboratorium.**

Hillerød: **Universitetets Ferskvandsbiologiske Laboratorium:** — Situated on the shore of shallow Frederiksberg Castle Lake for the purpose of research and instruction in freshwater biology. Sponsored by the University of Copenhagen under the direction of Professor KAJ BERG. There is a 2-story, well-equipped laboratory building. A 3-week course is offered in summer to university students in fresh-water biology. — *Cf.* Int. Rev. Hydrobiol. 3:128-35; Arch. für Hydrobiol. 32(4):1-6; SCOURFIELD 1905; KOFOID 1910; JUDAY 1910; LENZ 1927; RICKER 1937.

Noudby (Skalling Peninsula): **Skalling-Laboratoriet:** — Sponsored by the Carlsberg Foundation for investigations of marshes, dunes, and sandflats. Two field laboratories are available to investigators, one in Noudby Harbor and another on Skalling Peninsula. — *Station publication:* Meddelelser fra Skalling-Laboratoriet (1935-).

* Territorial boundaries as of August 1938.

— *EGYPT* —

Alexandria: **Fouad I Institute of Hydrobiology and Fisheries:** — Founded in 1931 and now sponsored by the Egyptian Ministry of Commerce and Industry for research on the marine and fresh-water fishes of Egypt. Dr. Hussein Faouzi is the director of a staff of five research assistants. The 3-story laboratory building contains a public aquarium, offices, library, museum, and many well-equipped laboratories. Services of the government, 42-meter Mabahiss, are available. — *Station publication:* Notes and Memoirs of the Fouad I Institute of Hydrobiology and Fisheries (1933-). — *Cf.* Int. Rev. Hydrobiol. 30:383; Nature 141:1107; Vaughan 1937.

Ghardaqa: **Marine Biological Station of the Fouad I University:** — Founded in 1930 by Dr. Cyril Crossland for the Faculty of Science of the Fouad I University. On the Red Sea, at the most northernly extension of the Indo-Pacific fauna. Every variety of coral reef is to be found within easy reach of the station. There are several well-equipped laboratory and living buildings. Boats are available. The station is open throughout the year, although optimum climatic and collecting conditions are during the summer months. — *Station publications:* Announcement; Publications of the Marine Biological Station, Ghardaqa (1939-). — *Cf.* Nature 126: 991-93; *Ibid.* 134:743-44; Chronica Botanica 1935; Vaughan 1937.

Heliopolis (Cairo): **Institute of Desert Researches.**

— *EIRE* —

Lough Ine (Skibbereen, County Cork): **Cork University Biological Station:** — On a tidal marine lough communicating with the sea by a very narrow-stepped channel. Founded in 1925 by Professor Louis P. W. Renouf and now sponsored by University College, Cork, for the purpose of working out the ecology of the immediate neighborhood and providing research facilities to visiting biologists. Courses offered in marine biology and ecology. — *Cf.* Journal of Ecology 19(2):410-38.

— *ENGLAND* —

Ambleside (Westmoreland): **Laboratory of the Freshwater Biological Association of the British Empire:** — Founded in 1929 to promote the investigation of the biology of the animals and plants found in fresh (and brackish) waters. Sponsored by the Freshwater Biological Association of the British Empire with a budget of £4,084. Dr. E. B. Worthington is director of a staff of seven resident investigators. The station is housed in Wray Castle and is equipped with modern laboratory and living facilities. A course is offered in the principles of freshwater biology. — *Station publications:* Annual Report of the Freshwater Biological Association of the British Empire; Scientific Publication (1939-). — *Cf.* Science 72:554; Nature 125:241-42; Science 76:248; Nature 130:140; Int. Rev. Hydrobiol. 30:247-50; Nature 142:238; Chronica Botanica 1938 and 1939.

Blakeney Point (Norfolk): **Blakeney Point Research Station:** — Situated on a peninsula on the Norfolk coast, with sand dunes, salt marshes, and mud flats easily accessible. Founded in 1913 for research in the ecology and ornithology of the region. — *Station publications:* Blakeney Point Publications (1912-); Occasional Reports of the Blakeney Point Research Station (usually appearing in the Transactions of the Norfolk and Norwich Naturalists' Society).

Cullercoats (Northumberland): **Dove Marine Laboratory:** — Founded in 1897 by Prof. Alexander Meek and now sponsored by Armstrong College of the University of Durham, with A. D. Hobson as director. The 2-story laboratory building contains rooms for the classes held each Easter holiday. — *Station publication:* Dove Marine Laboratory Report. — *Cf.* Juday 1910; Kofoid 1910; Magrini 1927; Vaughan 1937.

Plymouth: **Plymouth Laboratory of the Marine Biological Association of the United Kingdom:** — The Devon and Cornwall shore line supports an extensive and varied fauna which is exposed by the considerable rise and fall of the tide. The station was established in 1884, opened in 1888, with additions erected in 1920, 1922, 1926, and 1939. It is sponsored by the Marine Biological Association of the United Kingdom on a budget of £16,000 annually. Dr. Stanley Kemp is director and there are twelve resident members of the staff. The plant consists of three, well-equipped laboratory buildings which contain a public aquarium, a 20,000-volume library, biological supply

sales department, classrooms, and research laboratories. The 88-foot steamer, Salpa, is equipped for trawling and plankton work and the 25-foot motorboat, Gammarus, is also available. Courses in marine biology are offered during the Easter and autumn vacations. Laboratory accommodations are available for thirty investigators in addition to the resident staff. — *Station publications:* Journal of the Marine Biological Association of the United Kingdom (1889-); Report of the Council; Syllabus of the Course in Marine Biology; Guide to the Plymouth Aquarium. — *Cf.* The Times, London, March 31, 1884; *Ibid.* April 1, 1884; Nature 30:40, 82, 323, 350-51; Jour. Marine Biol. Assoc. 1:96-104; Nature 38:16-17; *Ibid.* 38:198-200; *Ibid.* 38:236-37; Jour. Marine Biol. Assoc. 15:734-828; New Statesman 28:105-06; Science 76:586; *Ibid.* 93:445; Dean 1894; Sand 1898; Juday 1910; Kofoid 1910; Magrini 1927; Chronica Botanica 1935; *Ibid.* 1936; Vaughan 1937.

Port Erin (Isle of Man): **Marine Biological Station at Port Erin:** — On the Isle of Man in the middle of the Irish Sea and organized to provide research and instructional facilities in marine biology. Sponsored by the Department of Oceanography of the University of Liverpool with Prof. J. H. Orton as director. There is a well-equipped, 2-story laboratory building and one 20-foot motorboat. Courses are given by professors of public schools and universities who come to the station with their classes for 2-week sessions, usually during the Easter recess. — *Station publications:* Report of the Marine Biological Station at Port Erin (1888-); Memoirs on Typical British Marine Plants and Animals of the Liverpool Marine Biological Committee (1899-); Proceedings and Transactions of the Liverpool Biological Society (1886-); General Regulations for Students. — *Cf.* Int. Rev. Hydrobiol. 1:740-45; Nature 82:321-22; Proc. Trans. Liverpool Biol. Soc. 34:23-74; Nature 146:58; Science 95:473; Dean 1894; Sand 1898; Juday 1910; Kofoid 1910; Magrini 1927; Chronica Botanica 1936; Vaughan 1937.

Potterne (Wilts.): **Potterne Biological Station:** — *Cf.* Chronica Botanica 1:178; *Ibid.* 2:190.

Southampton: **Southampton Fisheries Station:** — On the River Itchen within easy access to a large variety of water conditions. Founded in 1932 as the Avon Biological Research Station by University College, Southampton, and now sponsored also by the Freshwater Biological Association of the British Empire. — *Station publication:* Annual Report of the Avon Biological Survey (1932-). — *Cf.* Chronica Botanica 1939.

— *ESTONIA* —

Tartu: **Kuusnõmme Bioloogia Jaam.**

— *FINLAND* —

Tvärminne: **Station Zoologique de Tvärminne:** — Readily accessible to the station is open sea (the Gulf of Finland) and also a long, fiord-like bay. Founded in 1902 and now sponsored by the University of Helsingfors with Prof. Alexander Luther as director. There is a 2-story building which is open to independent investigators from May fifteenth to September tenth. 3-week courses are given in aquatic zoology, hydrology, and plant physiology. — *Cf.* Lenz 1927; Jahresb. Westpr. Bot.-Zool. Ver. 47:67-68.

— *FRANCE* —

Aix-les-Bains (Savoie): **Station d'Etudes Hydrobiologiques du Lac du Bourget:** — In a region of many large and small lakes, two large rivers, and easily accessible to the lakes of higher altitude in the Savoian and Dauphin Alps. Sponsored by the National School of Waters and Forests at Nancy to facilitate biological researches on the fresh-water lakes in France. The 2-story building contains a public aquarium, library, research laboratories, and living rooms. Open from April to October to qualified investigators. — *Cf.* La Nature, Paris 65(1):401-03.

Ambleteuse (Pas-de-Calais): **Station Biologique de l'Université Catholique de Lille (Laboratoire Charles Maurice):** — Established in 1895 by Prof. Charles Maurice and now sponsored by the Catholic University of Lille. There is a laboratory building and also a chalet used for living accommodations. — *Cf.* Kofoid 1910; Magrini 1927.

Arcachon (Gironde): **Station Biologique d'Arcachon:**—Initiated in 1863 and sponsored by La Société scientifique d'Arcachon, with Prof. H. Sigalas as director. The

two buildings contain a public aquarium, museum, well-equipped research laboratories, and living accommodations. A 31-foot motorboat is available. — *Station publications:* Bulletin de la Station Biologique d'Arcachon (1895-); Règlement des Laboratoires. —*Cf.* DEAN 1894; SAND 1898; KOFOID 1910; MAGRINI 1927; VAUGHAN 1937.

Bagnères-de-Bigorre (Hautes Pyrénées): **L'Institut et Observatoire de Physique du Globe du Pic-du-Midi:** — On the summit (9,437 feet) of a mountain in the Pyrenees. Sponsored by the University of Toulouse to aid scientists in making available to them laboratory and living facilities for research in physics and biology in high altitudes. The two weather-proof buildings contain well-equipped laboratories, library, and living quarters.

Banyuls-sur-Mer (Pyrénées Orientales): **Laboratoire Arago de Banyuls-sur-Mer:** — Sponsored by the Faculty of Sciences of the University of Paris for research and instruction in marine biology. Prof. E. CHATTON is director and there is a resident scientific staff of three persons. The plant contains a public aquarium, museum, library, classrooms, living accommodations, and well-equipped laboratories. A two-week course in marine biology is given usually during the Easter vacation and again in September. — *Cf.* Revue Scientifique 3(1):577-79; Arch. Zool. 1(9):563-98; Revue Scientifique 35:371-74; La Nature, Paris 14:97-99; Revue Scientifique 47:673-80; Revue des deux Mondes 120:168-86; Arch. Zool. 3(3):1-42; *Ibid.* 3(6):1-35; *Ibid.* 3(9):1-42; Cosmos 55:367-70; Revue Scientifique 70:750-53; DEAN 1894; SAND 1898; JUDAY 1910; KOFOID 1910; MAGRINI 1927; VAUGHAN 1937.

Besse (Puy-de-Dôme): **La Station Biologique de Besse:** — At an altitude of 3,444 feet, in a region of more than 20 lakes of glacial and volcanic origin. Sponsored by the Faculty of Sciences of the University of Clermont for the purpose of studying the flora and fauna of the mountains, especially the limnology of the waters. The laboratory building contains living facilities and also classrooms for the two-week course given for university students in biology. — *Station publication:* Arvernia Biologica (including Annales de la Station Limnologique de Besse). — *Cf.* Revue Inter. de l'Enseignement 39:128-31; Ann. Biol. Lacustre 1:1-32; Revue générale Scientifique 37:613-14; La Nature, Paris 64(2):358-60; KOFOID 1910; LENZ 1927; Chronica Botanica 1939.

Cévennes: **Laboratoire de Montagne de l'Aigoual (Université de Montpellier):** — According to Dr. and Mrs. VERDOORN, who visited this in 1932, without laboratory facilities.

Concarneau (Finistère, Brittany): **Laboratoire de Zoologie et de Physiologie Maritimes du Collège de France:** — Founded in 1859 by Prof. COSTE and now sponsored by the College of France at Paris. The purpose of the institution is to facilitate research in pure and applied marine biology. The 2-story building is well-equipped and the scientific work is under the direction of Dr. R. LEGENDRE. — *Cf.* Nature 29:16-17; Ann. Soc. Belg. Micro. 28:1-44; Revue Scientifique 70:750-53; DEAN 1894; SAND 1898; KOFOID 1910; MAGRINI 1927; VAUGHAN 1937.

Dinard (Ille et Vilaine): **Laboratoire Maritime du Museum National d'Histoire Naturelle:** — At the mouth of the River Rance, with pronounced tides. Founded in 1882 and now sponsored by the National Museum of Natural History of Paris for research in oceanography and marine biology. The two buildings contain a public aquarium, marine museum, library, and research laboratories. The station is open from June to September. — *Station publication:* Bulletin du Laboratoire Maritime de Dinard (1928-). — *Cf.* La Nature, Paris 16(2):186-88; Ann. Scient. Nat. Zool. 7(1):1-46; SAND 1898; KOFOID 1910; MAGRINI 1927; VAUGHAN 1937.

Endoume: **Laboratoire Marion de Marseille:** — Sponsored by the Faculty of Science of the University of Marseilles for instruction and research in marine zoology. The 3-story building contains a public aquarium, marine museum, classroom, and research laboratories. — *Station publication:* Travaux du Laboratoire de Zoologie et du Laboratoire Marion. — *Cf.* Ann. Musée d'Hist. Nat. Marseille 3:7-18; DEAN 1894; SAND 1898; KOFOID 1910; VAUGHAN 1937.

Le Croisic (Loire Inférieure): **Laboratoire de Biologie Maritime de Le Croisic:** — Accessible to sandy shores, salt marshes, and sand dunes. Founded in 1920 by Prof. ALPHONSE LABBÉ and now sponsored by the School of the Practice of Medicine and Pharmacy at Nantes. Station open to a maximum of eight investigators from July to September. — *Cf.* MAGRINI 1927; VAUGHAN 1937.

Le Lautaret (Hautes Alpes): **Institut de Botanique Alpine Marcel Mirande:** —

On a mountain pass in the western Alps at an elevation of 6,888 feet, the region containing about 2,000 species of plants. Founded in 1899 by Prof. LACHMANN and now sponsored by the University of Grenoble for the purpose of culturing alpine plants of different regions of the world and of studying their biology and propagation. There is a large alpine garden, a museum, library, and research rooms. The station is open from July first to September first. — *Cf.* Université de Grenoble Annales *32*:1-31; La Nature, Paris 54(2):257-60.

Luc-sur-Mer (Calvados): **Laboratoire de Luc-sur-Mer de la Faculté des Sciences de Caen:**—Founded in 1874, the building now contains research laboratories, library, and marine aquarium. — *Cf.* SAND 1898; KOFOID 1910; MAGRINI 1927; VAUGHAN 1937.

Montpellier (Hér.): **Station Internationale de Géobotanique Méditerranéenne et Alpine:** — Founded in 1930 by an international committee of botanists and now directed by Prof. J. BRAUN-BLANQUET for the study of geobotany and the methods of phytosociology and ecology. The building contains well-equipped laboratories, herbarium, and library. The station is open from September to July, with facilities for work especially in the Alps during the summer months. — *Station publications:* Communications de la Station Internationale de Géobotanique Méditerranéenne et Alpine, Montpellier (1930-); Prospectus; Prodrome des Groupements Végétaux (1931-). — *Cf.* Rev. Bot. Appl. d'Agr. Col. 10:1-4; Chronica Botanica 1935; *Ibid.* 1936; *Ibid.* 1938 (on the new building).

Orédon (Hautes-Pyrénées): **Laboratoire Biologique du Lac d'Orédon:** — On the shore of a mountain lake at an altitude of 6,071 feet. Sponsored by the University of Toulouse to help scientific workers study mountain biology. The 2-story building contains laboratory and living accommodations. Open to investigators from July fourteenth to August thirteenth.

Roscoff (Finistère): **Station Biologique de Roscoff (Laboratoire Lacaze-Duthiers):** — Dedicated to research and instruction in marine biology and sponsored by the Faculty of Sciences of the University of Paris with an annual budget of 150,000 francs. Prof. CHARLES PÉREZ directs the work of the station, which consists of five buildings. These contain a herbarium, classroom, library, darkrooms, and well-equipped general and special laboratories. A 17-passenger bus and an 18-ton vessel, Dundee, are also attached to the station. Two courses are offered in marine biology. — *Station publications:* Travaux de la Station Biologique de Roscoff (1923-); Conditions d'Admission. — *Cf.* Arch. Zool. 1(3):1-38; *Ibid.* 1(6):311-62; *Ibid.* 1(9):543-62; Nature 29:16-17; Arch. Zool. 2(9):255-363; *Ibid.* 3(3):1-42; *Ibid.* 3(6):1-35; Ann. Soc. Belge Micr. 28:1-44; Science 28:479-80; Int. Rev. Hydrobiol. 1:282-88; *Ibid.* 2:493-97; L'Illustration 86(1):393-95; DEAN 1894; SAND 1898; JUDAY 1910; KOFOID 1910; MAGRINI 1927; VAUGHAN 1937; Bull. Soc. R. Bot. Belg. 46:224-249 (especially on phycological facilities).

Sète (Hérault): **Station Biologique de Sète:** — Founded in 1879 and now sponsored by the Institute of Zoology and General Biology of the University of Montpellier. The large, 2-story building contains a public aquarium, museum, classroom, library, living rooms, and several laboratories. — *Station publication:* Travaux de la Station de Sète. — *Cf.* DEAN 1894; SAND 1898; JUDAY 1910; KOFOID 1910; MAGRINI 1927; VAUGHAN 1937.

Tamaris-sur-Mer: **Station Maritime de Biologie de Tamaris:** — Sponsored by the Faculty of Sciences of the University of Lyon in order to study the flora and fauna of the region of Toulon. The large, Mooresque laboratory building is open to investigators from March fifteenth to May first and from June twentieth to October twentieth. — *Cf.* Bull. Soc. Amis de l'Univ. Lyon 11:244-56; SAND 1898; KOFOID 1910; MAGRINI 1927; VAUGHAN 1937.

Villefranche-sur-Mer (Alpes Maritimes): **Station Zoologique de l'Université de Paris à Villefranche-sur-Mer:** — On the shores of the Mediterranean Sea with an exceptional pelagic fauna, both in abundance and variety. Sponsored by the University of Paris to aid in research on different problems of marine biology. There is a well-equipped building for laboratory work and living accommodations. A 4-ton motorboat is available. Vacation course in marine biology offered during Easter recess. — *Station publication:* Travaux de la Station Zoologique de Villefranche-sur-Mer (1925-). — *Cf.* Arch. Sci. Phys. et Nat. 12:1-11; Ann. Soc. Belge Micr. 28:1-44; Int. Rev. Hydrobiol. 10:317-19; DEAN 1894; SAND 1898; JUDAY 1910; KOFOID 1910; MAGRINI 1927; VAUGHAN 1937.

Wimereux (Pas-de-Calais): **Station Zoologique de Wimereux:** — On the shore of the Straits of Dover and dedicated to research and instruction in zoology and botany. Established in 1874 by Prof. ALFRED GIARD and now sponsored by the Faculty of Sciences of the University of Paris with Prof. MAURICE CAULLERY as director. The laboratory buildings are open to investigators from April to October inclusive. — *Station publications:* Bulletin Biologique de la France et de la Belgique; Travaux de la Station Biologique de Wimereux (1879-). — *Cf.* Revue Scientifique 4:217-22; Revue de l'Enseignement des Sciences 1:329-38; Revue du Mois 6:385-99; DEAN 1894; SAND 1898; JUDAY 1910; KOFOID 1910; MAGRINI 1927; VAUGHAN 1937.

— *FRENCH INDO-CHINA* —

Cauda (Nhatrang, Annam): **Institut Océanographique de l'Indochine:**—In a region with rocky and sandy shores and coral reefs. Founded in 1922 and now sponsored by the Government-General of Indo-China for scientific researches in physical and biological oceanography and the establishment of a museum and aquarium. There is a well-equipped, 2-story building and the 147-foot research vessel, De Lanessan. — *Station publications:* Notes; Mémoires; Annual Report. — *Cf.* La Nature, Paris 65(1):452-53; MAGRINI 1927; VAUGHAN 1934; VAUGHAN 1937.

— *GERMANY** —

Bellinchen a. Oder: **Biologische Station Bellinchen:** — Located on the Oder River for the purpose of instruction and research in ecology and related subjects. Courses are given in faunistics, floristics, and ecology.

Dümmersee (near Osnabrück): **Forschungshütte des Landesmuseum Hannover:**— *Cf.* Chronica Botanica 1938.

Garmisch-Partenkirchen (Bayern): **Alpenlaboratorium auf dem Schachen bei Garmisch:** — At an altitude of 6,232 feet, this institution is sponsored by the Bavarian Ministry for Instruction and Culture and the Union for the Protection of Alpine Plants for the culture and study of alpine plants. Dr. F. C. v. FABER directs the work of the station, which is open to research workers from June fifteenth to October first.

Hallstatt: **Botanische Station in Hallstatt:** — A private laboratory sponsored by Dr. FRIEDRICH MORTON for investigating the natural history of Hallstatt and vicinity. Investigators may make use of the station's facilities. — *Cf.* Chronica Botanica 1:84; *Ibid.* 2:76; *Ibid.* 5:256.

Helgoland: **Biologische Anstalt auf Helgoland:** — An independent institution under the direction of Prof. A. HAGMEIER. The large, 6-story building contains workshops, darkrooms, culture rooms, offices, library, public aquarium, herbarium, class laboratories, and many research laboratories. The 112-foot research vessel, Makrele, is attached to the station. Four courses are given in marine biology. — *Station publications:* Helgoländer Wissenschaftliche Meeresuntersuchungen (1937-); Ordnung für Vergebung und Benutzung der Arbeitsplätze; Lehrveranstaltungen der Biologischen Anstalt.—*Cf.* Zool. Anz. 15:290-92; *Ibid.* 16:124-27; Bot. Centralblatt 54:139-42; Rept. Smithsonian Inst. for 1893:505-19; Wiss. Meeresuntersuch., Abth. Helgoland 1:1-36; Verh. Deutsch. Zool. Ges. 6:177-82; Verh. Zool.-Bot. Ges., Wien 47:47-54; Mitth. deutsch. Seefischerei-Ver. 15:107-19; Zeitschr. d. Ver. Deutsch. Ingen. 47:807-12; Zeitschr. f. Bauverwaltung 25:470-72; Naturwissenschaften 6:569-72; Der Fischerbote 11:184-88; Int. Rev. Hydrobiol. 10:727-39; Cons. Intern. Expl. Mer, Rapports et Procès-Verbaux des Réunions 47(3):17-33; Der Biologe 7(3):161-83; Westermanns Monatshefte 157:513-20; DEAN 1894; SAND 1898; JUDAY 1910; KOFOID 1910; MAGRINI 1927; VAUGHAN 1937.

Helgoland: **Vogelwarte Helgoland:** — Situated on the only island in a large area of the North Sea and consequently a frequent stopping place for migrating birds. Founded in 1909 for investigating the migration and protection of birds and for instruction in ornithology. The 2-story building contains bird collections, offices, library, classroom, and laboratories. There are bird-traps for banding in the adjacent gardens. A course is offered in ornithology. — *Cf.* Der V. Internat. Ornithol. Kongress 1910:564-75; Brit. Birds 27:284-89; Der Biologe 3(7):184-86; Vogelzug 7:35-50.

* Territorial boundaries as of March 1938 (*i.e.*, including Austria).

Husum (Schleswig-Holstein): **Zoologische Station.**

Kiel: **Institut für Meereskunde der Universität Kiel:** — Sponsored by the University of Kiel with Prof. A. REMANE as director. The 3-story building contains a number of well-equipped laboratories. — *Station publication:* Kieler Meeresforschungen (1936-37-). — *Cf.* Kieler Meeresforschungen 3:1-16; K. BRANDT, *Die* beiden Meereslaboratorien in Kiel (Conseil Perm. Int. pour l'Explor. de la Mer, 1926, pp. 16).

Kloster Hiddensee (Pommern): **Biologische Forschungsanstalt Hiddensee:** — Sponsored by the University of Greifswald and the Province of Pommern for instruction and research in the plant ecology and biology of the region. There is complete laboratory equipment, including an ornithological station. Vacation courses in ornithology, hydrobiology, and ecology are offered. — *Station publication:* Hydrobiologischer und Ökologischer Ferienkursus auf Hiddensee. — *Cf.* Chronica Botanica 1:145-46.

Krefeld: **Limnologische Station der Kaiser Wilhelm-Gesellschaft:** — Sponsored by the Kaiser Wilhelm-Gesellschaft and the City of Krefeld for the limnological examination of the lower Rhine waters. — *Station publication:* Natur am Niederrhein. — *Cf.* Zool. Anz. 80:336; Int. Rev. Hydrobiol. 22:128; Der Naturforscher 6(3):1-8; Chronica Botanica 1936; *Ibid.* 1938.

Langenargen: **Institut für Seenforschung und Seenbewirtschaftung der Kaiser Wilhelm-Gesellschaft:** — Located on the shore of Bodensee and sponsored by the Kaiser Wilhelm Institute for the purpose of freshwater investigation and instruction. Dr. HANS-JOACHIM ELSTER is director of the Institute, which is housed in a 3-story building. A 3-week course in limnology is offered each July. — *Cf.* Rivista di Biologia 2:550-52; Int. Rev. Hydrobiol. 9:235-36; *Ibid.* 15:258-63; Der Biologe 4:134-37; Arch. Hydrobiol. 33:164; Int. Rev. Hydrobiol. 38:512; LENZ 1927; RICKER 1937.

Lunz-am-See: **Biologische Station Lunz** (Kupelwiesersche Stiftung): — On the shores of Lunz Lake, a typical sub-alpine lake at an elevation of about 2,000 feet. Sponsored by the Academy of Sciences of Vienna and the Kaiser Wilhelm Institute for instruction and research in fresh-water and alpine ecology. Founded in 1906 by Dr. KARL KUPELWIESER and now directed by Dr. F. RUTTNER. The 2-story building contains work-shops, greenhouses, darkrooms, offices, library, and many laboratories. A 3-week course in hydrobiology is given each summer. — *Cf.* Die Umschau 10:944-47; Biol. Zbl. 26:463-80; Arch. Hydrobiol. 2:465-99; Int. Rev. Hydrobiol. 1:297-99; *Ibid.* 13:213; *Ibid.* 29:148-54; Naturwissenschaften 2:313-21; KOFOID 1910; JUDAY 1910; LENZ 1927; RICKER 1937; Abderhalden's Handb. 9, 2.

Plön (Holstein): **Hydrobiologische Anstalt der Kaiser Wilhelm-Gesellschaft:** — Located in a morainal lake district and dedicated to research in hydrobiology and limnology. Founded in 1892 by Dr. OTTO ZACHARIAS and now sponsored by the Kaiser Wilhelm Institute with Dr. A. THIENEMANN as director and Dr. FR. LENZ as director of scientific work. There is a well-equipped, 3-story building and a 32-foot motorboat. — *Cf.* Zool. Anz. 3(11):18-27; *Ibid.* 3(12):600-04, 655-56; Verh. Ges. dtsch. Naturf. Ärzte 63(11):120-21; Rev. biol. du Nord France 4:146-49; Zool. Anz. 15:36-39; Int. Rev. Hydrobiol. 1:507-09; SAND 1898; SCOURFIELD 1905; JUDAY 1910; KOFOID 1910; LENZ 1927; RICKER 1937.

Rossitten (Kurische Nehrung, Ostpreussen): **Vogelwarte Rossitten der Kaiser Wilhelm-Gesellschaft:** — On a great "migratory bridge" for birds near the Baltic Sea. Founded in 1901 and now sponsored by the Kaiser Wilhelm-Gesellschaft for research and instruction in ornithology. Dr. ERNEST SCHÜZ directs the work of the station, which is housed in four buildings and three field annexes. An elementary course in ornithology is offered early in October. — *Station publications:* Der Vogelzug; Lehrgang der Vogelwarte Rossitten. — *Cf.* Der Biologe 4:225-27; Vogelzug 9(2):70-90.

Saarbrücken: **Hydrobiologische Station:** — *Cf.* Int. Rev. Hydrobiol. 10:549-50; Rivista di Biologia 4:401-02.

Seeon (Chiemgau, Oberbayern): **Biologisches Laboratorium Seeon:** — A private laboratory sponsored by Prof. R. WOLTERECK for faunistic studies on differentiation of animal races in lakes and related habitats. Open to foreign investigators from April first to November first. — *Cf.* Int. Rev. Hydrobiol. 20:213-15.

Wasserburg (Bavaria): **Biologische Station Wasserburg am Bodensee:** — Sponsored by the Kaiser Wilhelm Institute (for some time directed by Dr. HELMUT GAMS) for researches in limnology and related subjects. — *Cf.* Int. Rev. Hydrobiol. 15:144; LENZ 1927.

— GREENLAND —

Godhavn (Disko Island): **Den Danske Arktiske Station:** — Well within the Arctic Circle (latitude: 69° 14′ N.) and near diversified arctic habitats. Founded in 1906 by MORTON P. PORSILD and now sponsored by the Government of Denmark for research in arctic science. The buildings contain good laboratory and living accommodations, a herbarium, and a library. Motorboats are available, as are sledges and camping equipment. The station is open throughout the year, being primarily a laboratory and not a base for travel. — *Station publication:* Arbejder fra den Danske Arktiske Station. — *Cf.* American Naturalist 39:505-06; Nature 108:320-21; Current History 16:637-41.

— HAWAII —

Honolulu: **Marine Biological Laboratory of the University of Hawaii:** — On the shore of Waikiki reef, a habitat rich in animal and plant forms. Established in 1920 and now sponsored by the University of Hawaii for instruction and research in marine biology. Prof. C. H. EDMONDSON directs the work of the station, the facilities of which are open to investigators between June and September. — *Cf.* Jour. Pan-Pacific Research Institute 6(2):6-9; MAGRINI 1927; Turtox 1937; VAUGHAN 1934; VAUGHAN 1937.

— HUNGARY —

Tihany: **Hungarian Biological Research Institute:** — On the shore of Lake Balaton, the largest lake in Central Europe. Established for biological investigations of the organisms living in the lake and general biological researches independent of local questions and sponsored by the Hungarian Ministry of Education. The station has an annual budget of 35,000 pengö. There are ten resident investigators, with Prof. GEZA ENTZ as director. The 4-story laboratory building is unusually well-equipped. Extension courses are given for middle-school teachers in biology. — *Station publications:* A Magyar Biologiai Kutatointezet Munkai (Arbeiten des Ungarischen Biologischen Forschungs Institutes) (1927-); Prospectus (in English). — *Cf.* Ann. Biol. Lacustre 14:205-07; Arch. Balaton. 1:1-14; Nature 120: 968-69; Int. Rev. Hydrobiol. 13:370-72; *Ibid.* 18:435-36; Bull. Mus. Hist. Nat., Paris 33:468-69; Nature 121:93; LENZ 1927; Chronica Botanica 1935; *Ibid.* 1936.

— INDIA —

Calicut (South Malabar): **West Hill Marine Biological Station:** — On a narrow belt of low land lying between the sea and the lofty Western Ghat Mountains. Sponsored by the Madras Department of Fisheries for marine fishery research in general. — *Cf.* VAUGHAN 1937.

Ennur (Madras): **Ennur Biological Station:** — Sponsored by the Madras Department of Fisheries to supply biological specimens, although investigators may make use of the station's facilities. — *Cf.* VAUGHAN 1937.

Pamban (Krusadai Island, Madras): **Krusadai Marine Biological Station:** — The surrounding flora and fauna are among the richest in south India. Established in 1930 by the Madras Department of Fisheries for marine fishery research. The station is fairly well-equipped and there is the motor launch, The Pearl. — *Cf.* VAUGHAN 1937.

— ITALY —

Cagliari (Sardinia): **Stazione Biologica:** — *Cf.* Int. Rev. Hydrobiol. 12:434-35; KOFOID 1910; JUDAY 1910.

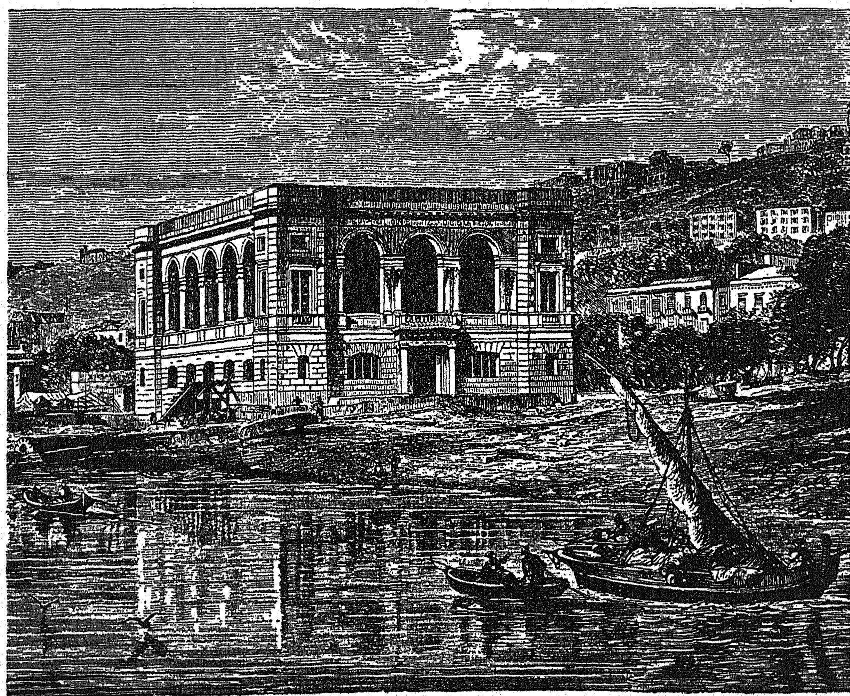
Col d'Olen (Alagna Sesia, Vercelli): **Istituto Scientifico Angelo Mosso sul Monte Rosa:** — In the Pennine Alps, at an altitude of 9,520 feet, with the cabin at Point Gnifetti at an altitude of 14,944 feet. Sponsored by the Royal University of Turin for scientific research in the mountains. The 3-story building contains laboratory and living accommodations. The institute is open during July and August. — *Station publication:* Atti del Laboratorio Angelo Mosso.

Messina (Sicily): **Istituto Centrale di Biologia Marina di Messina:** — Sponsored by the Royal Italian Oceanographical Committee for research in marine biology. — *Sta-*

tion publications: Memorie Istituto Centrale di Biologia Marina di Messina; Bolletino Istituto Centrale di Biologia Marina di Messina. — *Cf.* Revue Scientifique 55:381-86; MAGRINI 1927; VAUGHAN 1937.

Monte del Lago (Umbria): **R. Stazione Idrobiologica del Lago Trasimeno:** — Founded in 1922 by Prof. OSVALDO POLIMANTI and now sponsored by the Italian Ministry of Agriculture and Forestry to investigate the flora and fauna of the region. There is a 2-story laboratory building and a 25-foot motorboat. — *Cf.* Int. Rev. Hydrobiol. 9:546-50; *Ibid.* 11:565; Rivista di Biologia 6:566-74; Věda Přirodni 8:44-47; LENZ 1927; Chronica Botanica 1936.

Naples: **Stazione Zoologica di Napoli:** — On the Bay of Naples and dedicated to any kind of biological research by qualified investigators from any nation. Founded



DOHRN'S INTERNATIONAL ZOOLOGICAL STATION AT NAPLES, A SHORT TIME AFTER THE COMPLETION OF THE ORIGINAL BUILDING (*contemporary woodcut*).

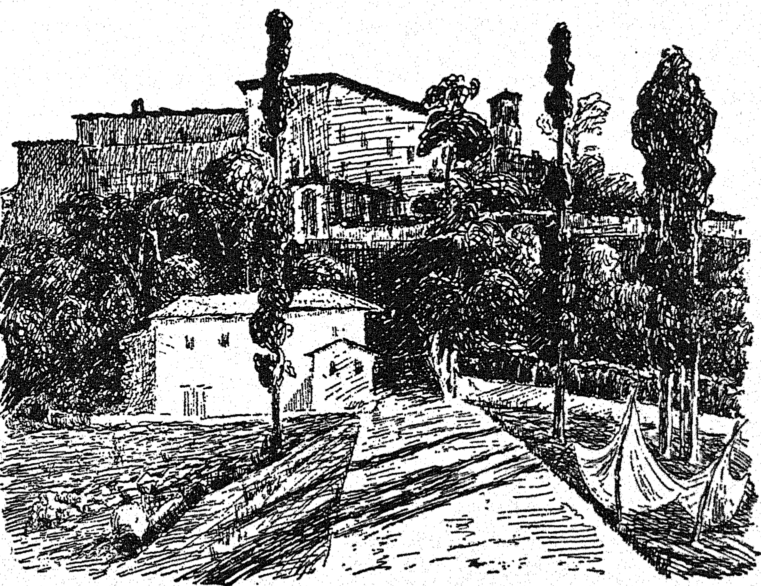
in 1870 by ANTON DOHRN, opened in 1874, with additions to building made in 1888 and 1903. Conducted as an autonomous institution with an annual budget of about 900,000 lire. Prof. REINHARD DOHRN heads the resident staff of five investigators. The 4-story building contains a public aquarium, supply department, public museum, darkrooms, workshops, offices, library, herbarium, kitchen, and various kinds of well-equipped laboratories. The station can accommodate 65 investigators at one time. — *Station publications:* Pubblicazioni della Stazione Zoologica (continuing Mitteilungen aus der Zoologischen Station zu Neapel) (1916-); Fauna e Flora del Golfo di Napoli (1880-); Regulations for Prospective Investigators; Prezzi di vendita degli animali marini conservati; Guide to the Aquarium of the Zoological Station at Naples. — *Cf.* especially bibliography in KOFOID 1910; Nature 5:277-80, 437-40; *Ibid.* 6:362-63, 535-36; *Ibid.* 8:81; Science n.s. 1:479-81, 507-10; *Ibid.* 2:93-97; Nature 43:392-93; *Ibid.* 48:440-43; Science 1:238-39; *Ibid.* 3:16-18; American Naturalist 31:960-65; Science 5:832-34; Bot. Gaz. 23:278-82; Popular Science Monthly 59:419-29; Science 16:993-94; Die Umschau 2:116-18; Science 25:355-56; *Ibid.* 36:453-68; Popu-

lar Science Monthly 77:209-25; Science 52:323-25; Int. Rev. Hydrobiol. 10:739-40; Rivista di Biologia 5:788; Science 59:361; *Ibid.* 59:182-83; Rivista di Biologia 6:255-61; Int. Rev. Hydrobiol. 12:266-67; Science 61:585-86; *Ibid.* 63:271; Naturwissenschaften 14:412-24; Science 65:289-90; *Ibid.* 90:206; Dean 1894; Sand 1898; Juday 1910; Kofoid 1910; Magrini 1927; Vaughan 1937.

Pallanza: **Istituto Italiano di Idrobiologia Dott. Marco de Marchi:** — Supervised by the Ministry of National Education for research in limnology. — *Cf.* Rivista di Biologia 25:438.

Piccolo San Bernardo (Aosta): **Giardino Alpino "La Chanousia" e Lab. di Botanica Alpina "De Marchi":** — *Cf.* Chronica Botanica 1:200; *Ibid.* 1:219.

Rovigno d'Istria: **Istituto Italo-Germanico di Biologia Marina di Rovigno d'Istria:** — Established in 1870 at Trieste by Dr. O. Hermes and moved to present site in 1891. Now sponsored by the Royal Italian Oceanographic Committee and the Kaiser



A view of the Hydrobiological Station at the Lago Trasimeno, Umbria, Italy, seen from the landing (*drawing by V. Bauer*).

Wilhelm Institute for instruction and research in marine biology, especially of the Adriatic Sea. The 4-story building contains a public aquarium, scientific sales department, museum, herbarium, offices, and research laboratories. — *Station publications:* Note (or Notizen) (1932-); Thalassia (1938-); Announcement; Liste der abgebbaren Seetiere und-pflanzen für wissenschaftliche Institute und den biologischen Unterricht. — *Cf.* Zool. Anz. 16:356-71; *Ibid.* 16:401-04; Int. Rev. Hydrobiol. 1:297; *Ibid.* 3:258-61; Die Naturwissenschaften 22:1-8; Rivista di Biologia 2:546-49; Int. Rev. Hydrobiol. 10:551; *Ibid.* 10:739-40; Science 58:9; Dean 1894; Sand 1898; Juday 1910; Kofoid 1910; Magrini 1927; Vaughan 1937.

San Guiliano: **Laboratorio di Biologia Marina per il Mare Ligure:** — On the rocky beach of the Ligurian Sea. An autonomous institution owned by Professors Alessandro Brian and Renato Santucci to aid in the study of marine biology. — *Cf.* Int. Rev. Hydrobiol. 5:179-80; Arch. Zool. Ital. 23(9-10); Rivista di Biologia 22:535-48; Magrini 1927; Vaughan 1937.

Taranto: **Istituto Demaniale di Biologia Marina di Taranto:** — Sponsored by the National Research Council of the Ministry of National Education for research in general marine biology. Prof. Attilio Cerruti directs the work of the station, which is

housed in a 3-story, well-equipped building. The 33-foot vessel, Galeso, is available as are two motorboats and two sailboats. — *Cf.* Rivista di Biologia 3:379-90; Int. Rev. Hydrobiol. 10:196; *Ibid.* 29:294-95; Rivista di Biologia 15:386-90; MAGRINI 1927; VAUGHAN 1937.

— *JAMAICA* —

Cinchona: **Botanical Gardens:** — At various times these gardens have been used as an American biological station. *Cf.* VERDOORN, 1945, "Plants and Plant Science in Latin America", p. xxi: "Many botanists of today do not know of the early efforts to found an American Tropical Laboratory (*cf.* Bot. Gaz. 22:415 and 494, 1896, etc.), culminating in the establishment of a tropical biological station (in 1903) at Cinchona, Jamaica (*cf.* MAXON 1922, Smiths. Rept. for 1920, p. 529, etc.). — Still much less is known today of the grandiose plans of LUIGI BUSCAGLIONI, who planned a second 'hortus bogoriensis' on the Amazon (ca. 1900), traveling widely to obtain sympathy and support (for a pathetic account of his efforts *cf.* Nuovo Giorn. Bot. Ital. 9:1-32, 1902). — A plan to establish a British tropical research station at Jamaica has recently been developed by V. J. CHAPMAN (Nature 152:47, 1943)".

— *JAPAN* —

Akkeshi: **Akkeshi Marine Biological Station:** — On the sea front of the Gulf of Akkeshi with sandy beaches, rocky beaches, and a muddy bottom. Established in 1931 and sponsored by the Hokkaido Imperial University for research and instruction in biology. There is a 3-story building and a 26-foot motorboat, Misago. Course work is given in marine biology, marine invertebrate zoology, marine algae, experimental morphology, and physiology. — *Station publications:* Contributions from the Akkeshi Marine Biological Station; The Akkeshi Marine Biological Station (a guide printed in Japanese). — *Cf.* VAUGHAN 1937.

Asamushi (Aomori-ken): **Marine Biological Station of the Tohoku Imperial University:** — On the shore of Mutsu Bay, facing a shallow sea of about four fathoms in depth. Sponsored by the Faculty of Science of Tohoku Imperial University for research and instruction in marine biology. Founded in 1924 by Prof. SINKISHI HATAI and now directed by Prof. SANJI HOZAWA. The station contains a public aquarium, dormitories, library, classrooms, and well-equipped research laboratories. Three-week courses are given in marine biology, systematic botany, planktology, algology, comparative physiology, and seismology. — *Cf.* Records of the Oceanographic Works in Japan 1:26-38; VAUGHAN 1934; VAUGHAN 1937.

Fukushima (Kiso, Nagano Prefecture): **Kiso Biological Station:** — In a forested, mountainous region with torrential streams. Sponsored by Kyoto Imperial University to extend limnological researches to the life in streams and torrents.

Hunami-cho (Muroran, Hokkaido): **Institute of Algological Research:** —Founded in 1933 and now sponsored by Hokkaido Imperial University for research work on marine algae. Prof. Y. TAMADA directs the work of the institute which maintains laboratory and living accommodations. — *Station publication:* Reports from the Marine Station for Algological Research (in Japanese). — *Cf.* Chronica Botanica 1935; *Ibid.* 1936; VAUGHAN 1937.

Kannonji (Otsu, Shiga-ken): **Otsu Hydrobiological Station:** — On Biwa Lake, the largest in Japan, with a central basin about 100 meters in depth and surrounded by various types of shores. Founded in 1914 and now sponsored by the College of Science of Kyoto Imperial University for research and instruction in limnology and allied subjects. The 2-story building contains library, aquarium, offices, and laboratories. Courses given in physiology and freshwater biology. — *Station publication:* Contributions from the Otsu Hydrobiological Station. — *Cf.* Int. Rev. Hydrobiol. 28:350; LENZ 1927.

Kominato Bay (Chiba Prefecture): **Kominato Marine Biological Laboratory:** — On the rocky shores of Kominato Bay, the depth being 100 kilometers within four kilometers from shore. Sponsored by the Imperial Fisheries Institute for research and instruction in marine biology. — *Cf.* VAUGHAN 1937.

Misaki (Kanagawa Prefecture): **Misaki Marine Biological Station:** — Founded in 1885 by the College of Sciences of the Imperial University of Japan and now spon-

sored by the Imperial University of Tokyo for research and instruction in marine biology, oceanography, and allied sciences. The plant contains dormitories, aquarium, museum, seismographic apparatus, and many laboratories. Summer courses given in marine zoology. — *Station publication:* Journal of Faculty of Science, Section IV, Tokyo Imperial University. — *Cf.* Pop. Sci. Mon. 1904:195-204; SAND 1898; VAUGHAN 1934; VAUGHAN 1937.

Osshoro (Hokkaido): **Osshoro Marine Biological Station:** — *Cf.* VAUGHAN 1934.

Seto-Kanayama (Wakayama-ken): **Seto Marine Biological Laboratory:** — Established in 1922 by Prof. IWAJI IKEDA of Kyoto Imperial University for research work in marine biology and for the instruction of students at Kyoto Imperial University. The Laboratory is well-equipped and includes the use of the 19-ton collecting vessel, Nyusin Maru. Courses are given in anatomy, experimental zoology, algology, and elementary oceanography. — *Cf.* Records of Oceanographic Work in Japan 1(3):113-29; VAUGHAN 1934; VAUGHAN 1937.

Shimoda-machi (Shizuoka-ken): **Shimoda Marine Biological Station:** — Sponsored by the Tokyo University of Literature and Science for research and instruction. There is one laboratory building and several boats. Course work is given in zoology, botany, oceanography, and science education. — *Cf.* VAUGHAN 1937.

Susaki (Kamogun, Siduoka Prefecture): **Mitsui Institute of Marine Biology:** — Adjacent tide pools and rocky strands abound in a rich fauna and flora. Established in 1933 by Mr. TAKANAGA MITSUI for the study of marine biology and to afford facilities for the research workers at the station. It is an autonomous institution with an annual budget of 25,000 yen. The 2-story building contains an aquarium, museum, library, and well-equipped laboratories. Fellowships are awarded annually by the station to research workers who desire to investigate marine material at the station.— *Cf.* VAUGHAN 1937.

Tomioka (Amakusa, Kumamoto Ken): **Amakusa Marine Biological Laboratory:** — Sponsored by Kyushu Imperial University. — *Cf.* Records of the Oceanographic Works in Japan 1(2):78-89; VAUGHAN 1934; VAUGHAN 1937.

— *LATVIA* —

Riga: **Hydrobiologische Station der Lettländischen Universität:** — Founded in 1924 and now sponsored by the University of Latvia for research and instruction in hydrobiology. Prof. EMBRIK STRAND directs the work of the station, which is housed in one of the university buildings in Riga. There is a field annex at Kurland on Lake Usmaitenschen. — *Station publication:* Folia Zoologica et Hydrobiologica. — *Cf.* Int. Rev. Hydrobiol. 12:435; *Ibid.* 21:478-80; LENZ 1927; VAUGHAN 1937.

— *MANCHUKUO* —

Harbin: **Sungari River Biological Station:** — *Cf.* LENZ 1927.

— *MARTINIQUE* —

Fort de France: **Museum et Laboratoire Océanographique de M. Conseil:** — *Cf.* MAGRINI 1927.

— *MEXICO* —

Pátzcuaro (Michoacán): **Estación Limnológica:** — On Lake Pátzcuaro at an altitude of over 6,000 feet. Sponsored by the Division of Fisheries of the Department of Marine of the Mexican Government to investigate the facilities of the lake as a center of fishing and to make a general survey of the lake. Mr. MANUEL ZOZAYA is director and Dr. FERNANDO DE BUEN is scientific advisor. There are ample laboratory and living facilities. — *Cf.* The Collecting Net 15:202.

— *MONACO* —

Monaco-ville: **Musée Océanographique et Aquarium de Monaco:** — On the Mediterranean Sea, with the shore sloping abruptly to deep water, often 300 to 500 meters in depth within three miles from shore. Founded in 1899 by ALBERT I, Prince of

Monaco, for original research in marine subjects and public education in oceanography. It is an autonomous institution, being a part of the Institute of Oceanography at Paris. Dr. JULES RICHARD is director of the institution, which has an annual budget of 1,300,-000 francs. The large, 4-story building contains a large public museum of oceanography, public aquarium, library, offices, darkrooms, and well-equipped laboratories. The 25-ton, 54-foot steamer, Eider, is available for collecting. The station is open from October first to July twenty-fifth. — *Station publications:* Bulletin de l'Institut Océanographique (1904-); Les Résultats des Campagnes Scientifiques de S.A.S. Prince Albert Ier de Monaco (1889-); Règlement Général Concernant l'Admission des Travailleurs faisant des Recherches; Musée Océanographique et Aquarium de Monaco (Guide Illustré). — *Cf.* Int. Rev. Hydrobiol. 1:504-07; Science 63:468-69; JUDAY 1910; KOFOID 1910; MAGRINI 1927; VAUGHAN 1937.

— *MOROCCO* —

Rabat: **Institut Scientifique Chérifien:** — Sponsored by the Direction of Public Education of Morocco for scientific research in French Morocco. Dr. J. DE LÉPINEY directs the work of the station, which has an annual budget of 650,000 francs. — *Cf.* Chronica Botanica 1936.

— *THE NETHERLANDS* —

Abcoude: **Laboratory of the Hugo de Vries Foundation:** — *Cf.* LENZ 1927; Chronica Botanica 1935; *Ibid.* 1936.

den Helder: **Zoölogisch Station der Nederlandsche Dierkundige Vereeniging:** — At the mouth of the Zuiderzee, close to the large sandflat area of northern Holland. Founded in 1876 and now sponsored by the Netherlands Zoological Society and the Netherlands Ministry of Education, Arts, and Sciences for marine biological investigations in the widest sense of the term. Dr. J. VERWEY directs the work of the station, which has an annual budget of 12,700 guilders. The 2-story building contains a public aquarium, library, office, classroom, and well-equipped laboratories. There is also a building with living accommodations. The 43-foot vessel, Max Weber, is available for collecting. — *Cf.* Arch. Zool. 1(6):312-19; Nature 29:16-17; Tijdschr. Nederl. Dierk. Vereen. 3:309-16; Feuille des Jeunes Natur. 19:17-19; Tijdschr. Nederl. Dierk. Vereen. 2(19):21-45; DEAN 1894; SAND 1898; JUDAY 1910; KOFOID 1910; VAUGHAN 1937.

Wijster (Drenthe): **Biologisch Station te Wijster:** — In the most extensive heath- and moor-land district of the Netherlands. Founded in 1927 by Dr. W. BEIJERINCK and now sponsored by the Netherlands Biological Station, an autonomous institution. There is good equipment for field research. — The scientific work originating from the station is marked, Mededeelingen van het Biologisch Station te Wijster. — *Cf.* Botany in the Netherlands, Sixth Int. Bot. Congr. 1935:80; Vakl. Biol. 19(2):17-25.

— *NETHERLANDS EAST INDIES* —

Batavia (Java): **Laboratorium voor het Onderzoek der Zee:** — Adjacent to salt- and brackish-water communities, coral reefs, and mangrove. Sponsored by the Netherlands East Indies Government and managed by the Botanical Gardens of Buitenzorg for scientific marine investigations. There are ample laboratory facilities. — *Cf.* Int. Rev. Hydrobiol. 10:195-96; Annales du Jardin Botanique de Buitenzorg 45:121-28; Natuurkundig Tijdschrift voor Nederlandsch-Indië 97:111-20; VAUGHAN 1934; VAUGHAN 1937.

Buitenzorg (Java): **Treub Laboratory** (Visitors' Laboratory) **of the Govt. Botanical Gardens:** — In the midst of the tropical lowland vegetation of 's Lands Plantentuin. Founded in 1884-85 by Prof. M. TREUB and now sponsored by the Botanical Gardens of Buitenzorg for use by foreign scientists who want to do laboratory work in the Botanical Gardens. — *Cf.* Bot. Ztg. 42:752-61, 768-80, 784-91; Pop. Sci. Mon. 67:579-89; Science 80:33-34; Ann. Jard. Bot. Buitenz. 45:1-60; Chronica Botanica 1935; *Ibid.* 1936; "Science and Scientists in the Netherlands Indies," p. 59, 1945.

Tjibodas (near Sindanglaija, W. Java): **Mountain Gardens and Biological Laboratory of the Govt. Botanical Gardens:** — Near the virgin forest (elevation between

4,500 and 9.800 feet). Founded in 1891 by Prof. M. TREUB and now sponsored by the Botanical Gardens of Buitenzorg. Laboratory and living accommodations are available. — *Cf.* Revue générale Scientifique 46:631-37, 664-68; Chronica Botanica 1935; "Science and Scientists in the Netherlands Indies," p. 403, *seq.*, 1945.

—NEW CALEDONIA—

Nouméa: **Marine Station:** — *Cf.* VAUGHAN 1934.

—NEW ZEALAND—

Portobello: **Portobello Marine Biological Station:** — Sponsored by the government of New Zealand for the study of New Zealand marine life. The buildings contain a public aquarium, library, scientific sales department, and laboratories. — *Cf.* VAUGHAN 1937.

—NORWAY—

Drøbak: **Universitets Biologiske Stasjon, Drøbak:** — Established in 1892 and now sponsored by the University of Oslo for marine research. Prof. HJALMAR BROCH directs the work of the station, which is housed in a 3-story building. Station open during July and August to students and investigators. — *Cf.* Dtsch. med. Wschr. 20:879; Nyt Mag. Naturv. 42:32; DEAN 1894; SAND 1898; JUDAY 1910; KOFOID 1910; MAGRINI 1927; VAUGHAN 1937.

Herdla: **Bergens Museums Biologiske Stasjon:** — Types of all prominent ecological habitats of the Norwegian Coast can be reached from this station within two hours. Founded in 1891 and now sponsored by the Bergen Museum for instruction and research in marine biology. Prof. AUGUST BRINKMANN is director of the station which has an annual budget of 25,000 Kroner. The 2-story building contains classrooms, living quarters, library, and several kinds of laboratories. The 48-foot vessel, Herman Friele, is available for research. — *Cf.* Bergens Museums Aarsberetning 1890(5):1-31; Bergens Museums Aarbok 1892(5):1-8; Zool. Anz. 16:217-20; Int. Rev. Hydrobiol. 1:299-300; Nature 111:358; Science 58:24-25; Int. Rev. Hydrobiol. 11:221; Bergens Museums Aarbok 1921-22(1):1-28; Bergens Museums Aarsberetning 1931-32:58-60; DEAN 1894; SAND 1898; JUDAY 1910; KOFOID 1910; VAUGHAN 1937.

Tromsø: **Biological and Hydrographic Laboratory of the Tromsø Museum:** — Established in 1930 by Mr. T. SOOT-RYEN and sponsored by the Tromsø Museum for scientific marine investigations in northern Norway. Space is available in the building of the Tromsø Museum and the 38-foot Sparre Schneider is available. — *Cf.* VAUGHAN 1937.

Trondheim: **Trondheims Biologiske Stasjon:** — An autonomous institution, subsidized by the Norwegian Government for the purpose of making hydrographical and biological investigations in the fiords and coasts of Norway. — *Cf.* Ann. Mag. Nat. Hist. 12:341-67; *Ibid.* 13:112-33, 150-64, 267-83; *Ibid.* 15:476-94; VAUGHAN 1937.

—PANAMA (CANAL ZONE)—

Gatun Lake: **Barro Colorado Island Biological Laboratory:** — On an island (six miles square with over 25 miles of shore line) largely covered with primeval rain forest (lower tropical zone). Established in 1924 and now sponsored by the Board of Directors of the Canal Zone Biological Area. Investigators desiring to visit the laboratory must obtain credentials from the Directors; this entitles them to secure steamship concessions, a pass on the Panama Railroad, and other privileges.—*Station publication:* Annual Report of the Barro Colorado Island Biological Laboratory (1926-). — *Cf.* Science 59:521-22; Jour. Hered. 15:99-112; Nation's Health 6(7):489-90; Science 62:111; Report of the Smithsonian Institution for 1926:327-42; Science 72:457; Nature Mag. 15:11-15; Atlantic Monthly 145:749-58; Wilson Bull. 42:225-32; Bull. Pan-American Union 67:43-51; Entomologist 66:217-21; Travel 63(2)15-19; Revue des Deux Mondes 25:30-34; Survey Graphic 24(4):192-93; Scientific Monthly 47:364-69.

—PHILIPPINE ISLANDS—

Puerto Galera (Island of Mindoro): **Puerto Galera Marine Biological Laboratory of the University of the Philippines:** — Sponsored by the Univ. of the Philippines

to provide biologists place and equipment for carrying out investigations on marine animals and plants. Mr. HILARIO A. ROXAS directs the work of the station, which offers both laboratory and living accommodations to students and investigators. — *Cf.* Int. Rev. Hydrobiol. 5:183; *Ibid.* 6:325-34; VAUGHAN 1934; VAUGHAN 1937.

— *POLAND* —

Hel: **Station Maritime de Hel:** — Founded in 1932 and now sponsored by the Ministry of Public Instruction and the Ministry of Commerce. — *Cf.* Chronica Botanica 1936.

Pińsk: **Poleska Stacja Biologiczna w Pinsku:** — In a vast marshy plain among many slow-running rivers. Sponsored by the Nencki Institute of Biology to study the limnological problems of rivers and marshes. Dr. JERZY WISZNIEWSKI directs the work of the station, which is housed in a 2-story building. A vacation course in hydrobiology is given. — *Cf.* Archives d'Hydrobiologie et d'Ichthyologie 10(4):431-34, 434-36; Chronica Botanica 1938.

Suwalki: **Stacji Hydrobiologicznej na Wigrach:** — On the shores of Lake Wigry, one of a group of more than 20 post-glacial lakes in the area. Sponsored by the Ministry of Education for the study of freshwater problems. Dr. ALFRED LITYŃSKI directs the work of the station, which has an annual budget of 30,000 zloty. A course is given in theoretical limnology. — *Station publication:* Archiwum Hydrobiologyi i Rybactwa (1926-). — *Cf.* LENZ 1927.

— *PORTUGAL* —

Dafundo: **Aquário Vasco da Gama—Estação de Biologia Maritima:** — Supported by the Fisheries Administration of the Ministry of Marine for general marine research on the coast of Portugal. There is a public aquarium, well-equipped laboratories, and the 135-ton research ship, Albacora. — *Station publication:* Travaux de la Station de Biologie Maritime de Lisbonne. — *Cf.* MAGRINI 1927; VAUGHAN 1937.

Porto: **Station de Zoologie Maritime "Augusto Nobre".**

— *RHODES* —

Rodi: **Istituto di Ricerche Biologiche in Rodi:** — An island in the Aegean Sea at the eastern end of the Mediterranean. Founded in 1936 and now sponsored by several Italian governmental agencies for research in the oceanographical, biological, and chemical sciences. The modern, 2-story building contains a large public aquarium, museum, library, and research laboratories. — *Cf.* VAUGHAN 1937.

— *ROUMANIA* —

Agigea: **Statiunea Zoologica Maritima "Regele Ferdinand I":** — Sponsored jointly by the Roumanian Ministry of National Education and the Laboratory of Zoology of the University of Iaşi for investigating the fauna of the Black Sea and neighboring lakes. Prof. C. MOTAS directs the work of the station, which is housed in a 2-story building. Station open from June first to October first.—*Station publication:* Lucrările Statiei Zoologice Maritime "Regele Ferdinand I" dela Agigea (1938-). — *Cf.* Ann. Soc. Univ. Jassy 19:1-16; Buletinuel Soc. Natur. din România 11:1-6; Ann. Scient. de l'Univ. de Jassy 23(2):1-4; VAUGHAN 1937.

Mamaia: **Statiunea Bio-oceanografica dela Mamaia.**

Sinaia (Cumpatul): **Statiunea Zoologica din Sinaia:** — At an elevation of 2,788 feet in a forested zone with much rainfall. Sponsored by the Ministry of National Education for the study of the fauna and flora of the region of Mount Bucegi. Prof. A. POPOVICI-BAZNOSANU directs the work of the station, which is open from June first to November first. — *Cf.* LENZ 1927.

Stâna de Vale (Bihor): **Statiunea Botanica Stâna de Vale:** — Sponsored by the Botanical Institute of the University of Cluj for biological studies on the flora and vegetation of the Bihor Mountains and the cultivation of alpine plants at an altitude of 3,608 feet. A course is given in phytosociology. The station is open during July and August.

—*SCOTLAND*—

Millport (Buteshire): **Marine Biological Station of the Scottish Marine Biological Association:** — Founded in 1884-85 by Sir JOHN MURRAY and now sponsored by the Scottish Marine Biological Association to investigate the flora and fauna of the Clyde Sea area and provide facilities for research and study for students and others interested in such work. RICHARD ELMHIRST directs the work of the station, which has an annual budget of £4,261. The 2-story buildings contain a public aquarium, museum, offices, storeroom for sales department, library, classroom, and many well-equipped laboratories. The 40-foot vessel, M. B. Nautilus, is available and is equipped with a laboratory for three persons. Several courses are given. — *Station publications:* Annual Report of the Scottish Marine Biological Association; Price List of Specimens. — *Cf.* Jour. Marine Biol. Assoc. United Kingdom 1:218-43; Nature *72*:456; JUDAY 1910; KOFOID 1910; MAGRINI 1927; VAUGHAN 1937.

—*SPAIN**—

Chico: **Estación de Biología Marítima.**

Las Palmas (Canary Islands): **Laboratorio Oceanográfico de Canarias:** — Sponsored by the Spanish Institute of Oceanography for the systematic investigation of the oceanographic and biological conditions in the vicinity of the Canary Islands. — *Cf.* Instituto Espan. Oceanogr. Notas y Resúmenes 2(48):1-79; VAUGHAN 1937.

Málaga: **Laboratorio de Málaga — Instituto Español de Oceanografía:** — Founded on the Strait of Gibraltar in 1914 by Prof. ODÓN DE BUEN and now sponsored by the Spanish Institute of Oceanography for research in marine biology and oceanography. — *Cf.* VAUGHAN 1937.

Palma (Island of Mallorca, Balearic Islands): **Laboratorio Oceanográfico de Palma de Mallorca:** — Founded in 1906-07 by Prof. ODÓN DE BUEN and now sponsored by the Spanish Institute of Oceanography. The station is equipped with aquarium, museum, library, and several laboratories. — *Cf.* Bull. Soc. Zool. France 33:1-11; Int. Rev. Hydrobiol. 30:385-86; KOFOID 1910; MAGRINI 1927; VAUGHAN 1937.

San Sebastian: **Sociedad de Oceanografía de Guipuzcoa:** — *Cf.* MAGRINI 1927; VAUGHAN 1937.

Santander: **Laboratorio de Santander — Instituto Español de Oceanografía:** — Sponsored by the Spanish Institute of Oceanography to study the flora and fauna of the coastal regions of the Bay of Biscay. — *Cf.* KOFOID 1910; MAGRINI 1927; VAUGHAN 1937.

Valencia: **Laboratorio de Hidrobiología:** — *Cf.* Int. Rev. Hydrobiol. *7*:272-73; LENZ 1927.

Vigo: **Laboratorio de Vigo — Instituto Español de Oceanografía:** — *Cf.* VAUGHAN 1937.

—*SURINAM* (*Neth. Guiana*) —

Paramaribo: **Biological Station at the General Agricultural Experiment Station:** — Established in 1903 under the directorship of C. J. J. VAN HALL. The present director, Dr. G. STAHEL, is anxious to help visiting biologists. Modern laboratory facilities. *Cf.* Bot. Gaz. 36:238-239; Bot. Cbl. 92:371; West-Ind. Gids, June 1920.

—*SWEDEN*—

Abisko: **Abisko Naturvetenskapliga Station:** — *Cf.* Chronica Botanica 1935.

Aneboda (Ugglehult): **Limnologiska Laboratoriet i Aneboda:** — Founded in 1907-08 and now sponsored by the University of Lund for research and instruction in limnology. A small, 2-story building contains apparatus for limnological research. — *Cf.* Int. Rev. Hydrobiol. 1:745-46; *Ibid.* 2:331-32; *Ibid.* 22:272; LENZ 1927.

Barsebäckshamn: **Barsebäckshamns Havsbiologiska Station:** — On the Oresund Sound, with brackish water on the surface and salt water beneath. Founded in 1914 and now sponsored by the Zoological Institute of the University of Lund for research and instruction in marine biology. A course in marine biology is given at the station, which is open to investigators during June, July, and August. — *Station publication:*

* As of June 1936.

Kungl. Fysiografiska Sällskapets Handlingar, Lund, Series: Undersökningar över Oresund. — *Cf.* Chronica Botanica 1936.

Fiskebäckskil: **Kristinebergs Zoologiska Station:** — Near the mouth of Gullmar Fiord, a relatively deep bay with a belt of islands near its mouth. Established in 1877 by Prof. SVEN LOVÉN and now sponsored by the Royal Swedish Academy of Science for research and instruction in marine zoology. Prof. EINAR LÖNNBERG directs the work of the station, which has an annual budget of 27,262 kronen. The equipment includes a library, aquarium, darkrooms, living accommodations, several laboratories, and the 42-foot motorboat, Sven Lovén. Course work in marine zoology is given.— *Cf.* Natural Science 7(6):407-16; Ark. f. Zool. 4(5):1-136; Popular Science Monthly 76:125-35; SAND 1898; JUDAY 1910; KOFOID 1910; Chronica Botanica 1936; VAUGHAN 1937.

Fiskebäckskil: **Klubbans Biologiska Station:** — At the mouth of the Gullmar Fiord (with a maximum depth of 394 feet) on the coast of the Skagerak. Established by the University of Uppsala for instruction of university students in marine zoology. Prof. SVEN EKMAN directs the work of the station, which is solely to offer course work in marine zoology to university students. — *Cf.* VAUGHAN 1937.

Göteborg: **Oceanografiska Institutionen vid Göteborgs:** — Sponsored by the Royal Society of Göteborg for research and instruction in physical oceanography and related sciences. Dr. HANS PETTERSSON directs the scientific work of the station, which is housed in a new, 2-story building. Special equipment includes a hydrodynamic tank (17 × 2 × 1 meters) and a plankton shaft (2 meters in diameter and 12 meters in length). The station is not open during July and August. — *Station publication:* Meddelanden fran Oceanografiska Institutet vid Göteborg (1939-). — *Cf.* Nature 145:698; VAUGHAN 1937.

— SWITZERLAND —

Bourg St. Pierre (Valais): **La Linnaea—Jardin et Laboratoire Alpins:** — In a valley of the Alps at an altitude of 5,576 feet, the region containing a mixture of both an arctic and Mediterranean flora. Founded in 1883, and now sponsored by the Institute of General Botany of the University of Geneva for research and instruction in alpine botany. Prof. FERDINAND CHODAT directs the work of the station, which consists of a botanical garden with 2,000 species of alpine plants and a laboratory building. A course is given in the botany of the Alps. The station is open during July and August. — *Station publication:* La Linnaea — Jardin et Laboratoire Alpins (an announcement in French). — *Cf.* Chronica Botanica 1936.

Davos: **Hydrobiologisches Laboratorium der Landschaft Davos:** — *Cf.* LENZ 1927; Chronica Botanica 1936.

Interlaken: **Alpengarten und Laboratorium "Schynige Platte":** —*Cf.* Chronica Botanica 1935.

Jungfraujoch (Berner Oberland): **Hochalpine Forschungsstation Jungfraujoch:** — In a high, mountainous region at an elevation of 11,340 feet. Established by an autonomous council to enable research work in all branches of science to be carried out under the best possible conditions in a high mountain region. Prof. A. V. MURALT directs the work of the station, which has an annual budget of 24,000 Swiss francs. The 5-story building constructed in solid rock contains living quarters, darkrooms, library, lecture-room, workshop, and several well-equipped laboratories. Application for permission to work at the station must be made through one of the participating societies (Schweizerische Naturforschende Gesellschaft; Kaiser Wilhelm-Gesellschaft, Berlin; Université de Paris; Royal Society, London; Akademie der Wissenschaften, Wien; Fonds National de la Recherche Scientifique, Bruxelles; Rockefeller Foundation, New York; and Jungfraubahn-Gesellschaft, Berne). Investigators whose applications are approved receive a reduction in railway fares and exemption from customs duty on consignments of scientific apparatus entering Switzerland. — *Station publication:* Information and Regulations. — *Cf.* Chronica Botanica 1935.

Kastanienbaum (Horw): **Hydrobiologisches Laboratorium der Naturf. Gesellschaft Luzern:** — *Cf.* Arch. f. Hydrobiol. 10:113-18; Int. Rev. Hydrobiol. 9:236; Chronica Botanica 1935; *Ibid.* 1939; LENZ 1927.

Zürich: **Geobotanisches Forschungsinstitut Rübel:** — Established in 1918 by Dr. E. RÜBEL and now an autonomous institution for studies in plant taxonomy and ecology. The headquarters and equipment are at Zürich, but the course in the ecology of alpine

vegetation is given at Davos. — *Station publications:* Bericht über das Geobotanische Forschungsinstituts Rübel in Zürich; Veröffentlichungen des Geobotanischen Forschungsinstituts Rübel in Zürich.

— *TUNISIA* —

Salammbó: **Station Océanographique de Salammbó:** — Sponsored by the Direction Générale des Travaux Publics in Tunis to investigate the marine organisms along the coast of Tunisia. The equipment includes a public museum and aquarium, library, and several laboratories. — *Station publications:* Notes de la Station Océanographique de Salammbó; Bulletin de la Station Océanographique de Salammbó; Annales de la Station Océanographique de Salammbó; Illustrated Catalogue of the Museum and Aquarium. — *Cf.* Science 63:488; MAGRINI 1927; VAUGHAN 1937.

— *UNION OF SOCIALIST SOVIET REPUBLICS* —

Alt-Peterhof: **Hydrobiological Section of the Scientific Institute at Peterhof:** — Sponsored by the Ministry of Education for hydrobiological and hydrochemical investigation of animals. — *Station publication:* Travaux de l'Institut des Sciences Naturelles de Peterhof (1925-). — *Cf.* Chronica Botanica 1936; LENZ 1927.

Archangel: **Algological Research Station:** — *Cf.* Chronica Botanica 1936.

Cherson: **All-Ukrainian Scientific-Practical Station of the Black and Asov Seas:** — Founded in 1918 and now sponsored by the Ministry of Agriculture of the Ukraine Republic. — *Station publications:* Bulletin der Allukrainischen wissenschaftlich-praktischen Staatsstation des Schwarzen und des Azowschen Meeres; Arbeiten der Allukrainischen wissenschaftlich-praktischen Staatsstation des Schwarzen und des Azowschen Meeres (1925-). — *Cf.* LENZ 1927.

Elenowka (Armenia): **Sewan Lake Station:** — On Lake Goktscha in the Caucasus Mountains. Sponsored by the Ministry of Agriculture of the Armenian Republic for theoretical and practical investigations of Lake Goktscha. — *Station publication:* Arbeiten der Sewanseestation. — *Cf.* LENZ 1927.

Kossino: **Biological Station at Kossino:** — Founded in 1908 and now sponsored jointly by the Moscow Society of Nature Research and the Ministry of Education for theoretical investigations in biology. Prof. L. ROSSOLIMO directs the work of the station, which is housed in a 2-story building. — *Station publication:* Arbeiten der Biologischen Station zu Kossino (1924-). — *Cf.* Int. Rev. Hydrobiol. 17:386-87; *Ibid.* 25:303-04; Progressive Fish Culturist 34:12-14; LENZ 1927.

Kostroma: **Biological Station of the Scientific Society for the Investigation of the Kostroma Region:** — Founded in 1919 and now dedicated to theoretical research work on the Volga River. — *Station publication:* Arbeiten der Wissenschaftlichen Gesellschaft zur Erforschung des Lokalgebietes Kostroma. — *Cf.* LENZ 1927.

Krasnoyarsk (Siberia): **Siberian Ichthyological Laboratory:** —Sponsored by the Ministry of Agriculture for practical and theoretical investigations. — *Station publication:* Report of the Ichthyological Laboratory in Siberia. — *Cf.* Int. Rev. Hydrobiol. 11:391-92; LENZ 1927.

Lake Glubokoje: **Hydrobiological Station on Lake Glubokoje:** — Founded in 1888 and now managed by the Biological Station at Kossino for the Moscow Society of Naturalists. — *Station publication:* Arbeiten der Hydrobiologischen Station am See Glubokoje (1900-). — *Cf.* Trav. Soc. Imp. Acclim. 2:201-06; KOFOID 1910; LENZ 1927.

Maritui: **Baikal Hydrobiological Station:** — On Lake Baikal, one of the deepest lakes in the world (with a reputed depth of 4,725 feet). Sponsored by the Russian Academy of Sciences for theoretical and practical investigations. — *Station publication:* Arbeiten der Kommission für die Erforschung der Baikalsees. — *Cf.* LENZ 1927.

Mount Elbrus (Caucasus): **Institute of Research in High Altitudes:** — *Cf.* Science 87:550.

Murman: **Biological Station of the Academy of Sciences of the U. S. S. R. at Murman:** — On the Arctic Ocean which, owing to the penetration of the warm waters of the Atlantic, has an extremely rich and diverse fauna. Established in 1881 near Archangel, moved to near present site in 1899, and an announcement made in 1937 of plans to build a new station in the region to cost three and one-half million rubles. Sponsored by the Academy of Sciences of the U. S. S. R. with Prof. S. A. ZERNOV as

director. — *Cf.* Zool. Anz. 29:704-07; Ohio Naturalist 8:340-42; Int. Rev. Hydrobiol. 2:499-502; *Ibid.* 11:222-23; Science 67:158-59; *Ibid.* 85:536; Nature 139:725; Dean 1894; Sand 1898; Juday 1910; Kofoid 1910; Vaughan 1937.

Murom, Vladimir: **Oka Biological Station:** — Founded in 1918 and now sponsored by the Ministry of Education for theoretical and practical biological investigations. — *Station publication:* Arbeiten der Biologischen Oka-Station (Murom-Russland). — *Cf.* Lenz 1927.

Novorossiisk: **Novorossiisk Biological Station:** — Sponsored by the People's Commissariat of Education to investigate the practical problems and objects of the Black Sea. Mr. W. A. Wodjanitzky directs the work of the station, which has an annual budget of 66,200 rubles.—*Station publication:* Arbeiten der Biologischen Noworossijsk-Station. — *Cf.* Lenz 1927; Vaughan 1937.

Otusy (Krim) : **Scientific Station of the Moscow Nature Research Society:** — *Cf.* Chronica Botanica 1935.

Perm: **Biological Station at Perm on the Kama River:** — Sponsored by the Biological-Scientific Research Institute of the University of Perm. — *Station publication:* Bulletin de l'Institut des Recherches biologiques et de la Station Biologique à l'Université de Perm. — *Cf.* Lenz 1927.

Petrosavodsk: **Borodin Hydrobiological Research Institute:** — *Cf.* Kofoid 1910; Lenz 1927.

Preobrazenie (Siberia) : **Algological Research Station:** — *Cf.* Chronica Botanica 1935.

Saratov: **Volga Biological Station at Saratov:** — Founded in 1900 and now directed by Dr. A. Behning for scientific investigation of the life of the Volga and educational work in hydrobiology. Course work is given to students. — *Station publications:* Arbeiten der Biologischen Wolgastation (1900-) ; Monographien der Biologischen Wolgastation (1924-). — *Cf.* Int. Rev. Hydrobiol. 3:461-62; *Ibid.* 5:581-93; Rivista di Biologia 5:789-90; Int. Rev. Hydrobiol. 13:111-13; *Ibid.* 17:357-61; Rev. Algol. 4:77-80; Juday 1910; Kofoid 1910; Lenz 1927.

Sevastopol: **Sevastopol Biological Station:** — Sponsored by the Academy of Sciences of the U. S. S. R. for oceanographical and hydrobiological observations of the Black and Asov seas. The 3-story building contains a public aquarium, library, darkroom, and several well-equipped laboratories. Course work is given to university students. — *Station publication:* Memoirs of the Sevastopol Biological Station. — *Cf.* Bull. Biol. 1:280-85; Int. Rev. Hydrobiol. 1:861-63; *Ibid.* 9:555; Dean 1894; Sand 1898; Juday 1910; Kofoid 1910; Vaughan 1937.

Starosselje (Ukraine) : **Biological Station of the Dnieper:** — Founded in 1907 and now sponsored by the All-Ukraine Academy of Sciences for theoretical investigation of the Dnieper basin. — *Station publication:* Travaux de la Station Biologique du Dnieper (1926-). — *Cf.* Lenz 1927.

Swenigorod: **Hydrophysiological Station at Swenigorod on the Moskva:** — Sponsored by the National Scientific Institute of the Ministry of Health for theoretical research on the Moskva River. Prof. S. Skadowsky directs the work of the station.— *Cf.* Lenz 1927.

Vladikavkaz (Caucasus) : **North Caucasus Hydrobiological Station:** — Established in 1923 for theoretical hydrobiological investigation of alpine waters. — *Station publication:* Travaux de la Station Biologique du Cauc. du Nord (1925-). — *Cf.* Lenz 1927.

Vladivostok: **Pacific Institute of Fisheries and Oceanography:** — Near Ussuri Bay which is free from ice during the winter. Founded in 1925 under the direction of Prof. K. M. Derjugin and now sponsored by the All-Union Scientific Research Institution of Marine Fisheries and Oceanography for researches in the hydrology, hydrobiology, and ichthyology of the region. The plant contains a museum, aquarium, library, and several laboratories. — *Cf.* Int. Rev. Hydrobiol. 15:396-400; Fifth Pacific Science Congress 1:619-22; Vaughan 1934; Vaughan 1937.

— *UNION OF SOUTH AFRICA* —

Frankenwald: **Botanical Research Station of the University of Witwatersrand:** — *Cf.* Chronica Botanica 1939.

Sea Point: **Marine Biological Station of the Division of Fisheries:** — On the western side of the Cape Peninsula, with admirable opportunities for the study of marine flora and fauna. Established in 1939 by the Division of Fisheries of the Department of Commerce and Industry, being partially a continuation of the biological station founded in 1895 at St. James on False Bay. Dr. CECIL VON BONDE directs the work of the station, which has an annual budget of £13,000. The plant contains a library, darkroom, public aquarium, several laboratories, the 136-foot, 313-ton steam survey vessel, Africana, and a 50-foot motorboat, Impala. — *Station publications:* Annual Report of the Division of Fisheries; Investigation Reports. — *Cf.* VAUGHAN 1937.

— *UNITED STATES OF AMERICA* —

— *Arizona* —

Flagstaff: **San Francisco Mountain Zoological Station:** — At an altitude of 7,100 feet. Founded in 1926 by HAROLD S. COLTON and now sponsored by the Northern Arizona Society of Science and Art to form a center from which the biology, geology, ethnology, and archaeology of the Plateau of Northern Arizona may be studied. The station makes use of the facilities of the Museum of Northern Arizona. Open from June to September. — *Cf.* Science 69:132; Turtox 1932.

— *California* —

Angwin: **Pacific Union College Field Nature School:** — An itinerant field school, with headquarters at Pacific Union College. Prof. HAROLD W. CLARK directs the work of the school, which offers a course in field nature study every other summer. — *Cf.* Turtox 1937.

Corona Del Mar: **Kerckhoff Marine Laboratory:** — Sponsored by the California Institute of Technology for research in experimental embryology, physiology, marine ecology, biophysics, and chemistry to supplement that done at the sponsoring institution. Prof. G. E. MACGINITIE directs the work of the station, which is housed in a 2-story building. — *Cf.* VAUGHAN 1934; VAUGHAN 1937.

Dillon Beach: **Pacific Marine Laboratory:** — Founded in 1933 by the College of the Pacific for instruction and research in marine biology. Prof. ALDEN E. NOBLE directs the work of the station, which is open from June to September. Summer course work is given in general zoology and invertebrate zoology.

Laguna Beach (Orange County): **Laguna Beach Marine Laboratory:** — Founded in 1911 by Prof. C. F. BAKER and now sponsored by Pomona College for summer instruction in biology for undergraduate and graduate students. Prof. WILLIAM A. HILTON directs the work of the station, which is open during the summer months only. Summer course work is offered in the biology of vertebrates and invertebrates, human biology, human origins, and animal ecology. — *Cf.* Int. Rev. Hydrobiol. 7:134-35; Science 39:200-02; The Biologist 18:86-87; MAGRINI 1927; VAUGHAN 1934; VAUGHAN 1937; Turtox 1937.

La Jolla: **Scripps Institution of Oceanography:** — Within collecting range of the institution are long stretches of sandy shores interspersed with rocky reefs exposed to the open sea. Founded in 1892 by Dr. WILLIAM E. RITTER at Pacific Grove and moved to present site in 1905. Sponsored by the University of California for research and graduate instruction in oceanography and marine biology. Dr. HARALD U. SVERDRUP directs the work of the station, which has an annual budget of $110,000. The resident scientific staff consists of 12 persons. The equipment includes a public aquarium, 24 cottage residences, seismograph room, museum, offices, library, assembly room, many laboratories, a re-enforced concrete pier, and the 104-foot research vessel, E. W. Scripps. Course work is given in marine meteorology, physical oceanography, marine geology, chemical oceanography, marine microbiology, phytoplankton, marine invertebrates, marine biochemistry, and biology of fishes. — *Station publications:* Bulletin of the Scripps Institution of Oceanography of the University of California, Technical Series (1927-); annual reports on the activity of the institution appear in the Transactions, American Geophysical Union. — *Cf.* Harpers 110:456-63; Science 26:386-88; University of California Chronicle 9:1-7; Int. Rev. Hydrobiol. 1:863-65; University of California Publications in Zoology 9(4):137-248; Pop. Sci. Mon. 86:223-32;

School and Society 3:453-54; Science 63:297; Scientific Monthly 37:371-75; The Collecting Net 11(2):1-5; The Biologist 18:87-96; MAGRINI 1927; VAUGHAN 1934; Turtox 1937; VAUGHAN 1937.

Norden (Placer County): **San Francisco State College Science Field Session:**— Sponsored by San Francisco State College to provide opportunity for study in one of California's most attractive localities. Summer course work is given in astronomy, geology, and the flora and fauna of the Sierra. No research facilities.

Pacific Grove: **Hopkins Marine Station:**— In the Monterey Bay region, with extraordinarily rich fauna and flora. Founded in 1892 as the Hopkins Seaside Laboratory by DAVID STARR JORDAN, CHARLES HENRY GILBERT, and OLIVER PEEBLES JENKINS. Now sponsored by Stanford University to undertake research in biology, to provide facilities for visiting investigators, and to furnish elementary and advanced instruction in biology. Prof. WALTER K. FISHER directs the work of the station. The equipment includes a small museum, marine shop, library, offices, darkrooms, and many well-equipped laboratories. Summer courses are given in the ecology of marine organisms, marine biology, marine invertebrates, marine fishes, marine algae, general microbiology, comparative physiology, physiology of marine plants, and experimental embryology.— *Station publication:* Annual Bulletin of the Hopkins Marine Station.— *Cf.* Zoe 4:58-63; Natural Science 11:28-35; Overland Monthly n.s. 32:208; Jour. Applied Microscopy and Laboratory Methods 5:1869-75; Pop. Sci. Mon. 86:223-32; Science 47:410-12; Int. Rev. Hydrobiol. 10:547-49; Science 62:76; Scientific Monthly 29:298-303; The Collecting Net 6:65-71; The Biologist 18:96-99; SAND 1898; MAGRINI 1927; VAUGHAN 1934; Turtox 1937; VAUGHAN 1937.

San Jose: **West Coast School of Nature Study:**— Founded in 1931 and sponsored by San Jose State College to better prepare teachers for the "nature in the classroom" type of teaching. Prof. P. VICTOR PETERSON directs the work of the school, which is almost wholly in the field, and changes its site frequently. There are no research facilities.— *Cf.* Turtox 1937.

Santa Barbara: **Santa Barbara School of Natural Science:**— Sponsored by Santa Barbara State College in order to offer popular summer field courses in nature study for California teachers. No research facilities are available.— *Cf.* TURTOX 1937.

Yosemite National Park: **Yosemite School of Field Natural History:**— The fauna and flora of the area are extensive, due to the wide range of topography and elevation (2,000 to 13,000 feet). Founded in 1925 by Dr. HAROLD C. BRYANT and sponsored by the U. S. National Park Service to train students in methods of interpreting living nature and to train naturalists for the National Park Service. Mr. C. A. HARWELL directs the work of the school, which offers a 7-week course in natural history during the summer months. Research facilities are not available.— *Cf.* School and Society 32:590-92; Nature Magazine 19:274; Turtox 1937.

— *Colorado* —

Cuchara Camps: **Nature Enjoyment Camp:**— At an altitude of 8,200 feet in the Rocky Mountains. Founded in 1939 and sponsored by the Huerfano Group of the Colorado Mountain Club to train leadership in methods of out-of-door teaching and nature guiding. No research facilities are available.

Gothic (Gunnison County): **Rocky Mountain Biological Laboratory:**— In an area comprising about a half million acres of virgin territory, with elevations ranging from 8,000 to 14,000 feet. Founded in 1927 and sponsored by the Rocky Mountain Biological Laboratory, Inc., for research and instruction in subjects best studied in high mountain areas. Dr. JOHN C. JOHNSON directs the work of the station, which consists of 15 buildings and staff residences. Summer courses are given in ecology, field botany, parasitology, and other biological sciences and geology. The laboratory is open from June twentieth to September first.— *Cf.* The Biologist 18:105-08; Turtox 1937.

Mount Evans: **Mount Evans Laboratory:**— At the summit of Mount Evans, 14,250 feet above sea level. Founded in 1936 and now sponsored by the University of Denver and the Massachusetts Institute of Technology to study high altitude phenomena. Prof. J. C. STEARNS directs the work of the laboratory, which is equipped

with both scientific and living facilities. The laboratory is open from June to October. — *Cf.* Science 31:220; *Ibid.* 87:431-32; Scientific Monthly 46:242-48.

Nederland: **Science Lodge:** — On the flank of Mount Niwot, 9,500 feet above sea level, just below timberline and close to the continental divide. Sponsored by the University of Colorado for actual field experience in geology and biology. Summer courses are given in field biology and many phases of geology. The station is open from the third week of June to the fourth week of August. — *Cf.* Univ. Colorado Bull. 17(1):1-14; Science 56:162-63; The Biologist 18:101-04; Turtox 1937.

— Connecticut —

Lakeville: **Science of the Out-of-Doors:** — Established by Teachers College of Columbia University to give teachers guidance in the utilization of features in the natural phenomena of the out-of-doors. Prof. F. L. Fitzpatrick directs the work of this school, which offers a 4-week course in field work each summer. — *Cf.* The Biologist 18:109-10; Turtox 1937.

— Florida —

Belle Isle (Miami Beach): **Belle Isle Laboratory of the University of Miami:** — Located on an island on the auto causeway connecting the cities of Miami and Miami Beach. Within an area readily accessible to the laboratory is found a wide variety of aquatic habitats and the Gulf Stream is only a short distance from land. Established by the University of Miami with Dr. F. C. Walton Smith as director. Ample laboratory accommodations for classes and independent investigators are available and living facilities may be obtained nearby. — *Cf.* Science 98:141-43.

Englewood: **Bass Biological Laboratory:** — On Lemon Bay which opens into the Gulf of Mexico. Founded in 1932 by the late John F. Bass, jr. to furnish research facilities to investigators in biological fields where the fauna, flora, and climate play an important rôle in the problems under observation.

Pensacola: **Gulf Coast Fisheries Laboratory:** — Offshore the laboratory there are coral reefs and sand, mud, rock, and shell bottoms. Founded in 1937 and sponsored by the United States Fish and Wildlife Service for biological research on fisheries and related problems. Dr. A. E. Hopkins directs the work of the laboratory. The equipment includes a library, museum, dormitory, residences, boat house, several kinds of laboratories, and several boats. — *Cf.* Science 90:11; Proc. Fla. Acad. Sci. 4:175-78.

— Illinois —

Champaign: **University of Illinois Animal Ecology Study Trip:** — An itinerant field station sponsored by the Department of Zoology of the University of Illinois. Established in 1936 for instruction in animal ecology. Prof. V. E. Shelford directs the work of the study trip, which offers no facilities to investigators.

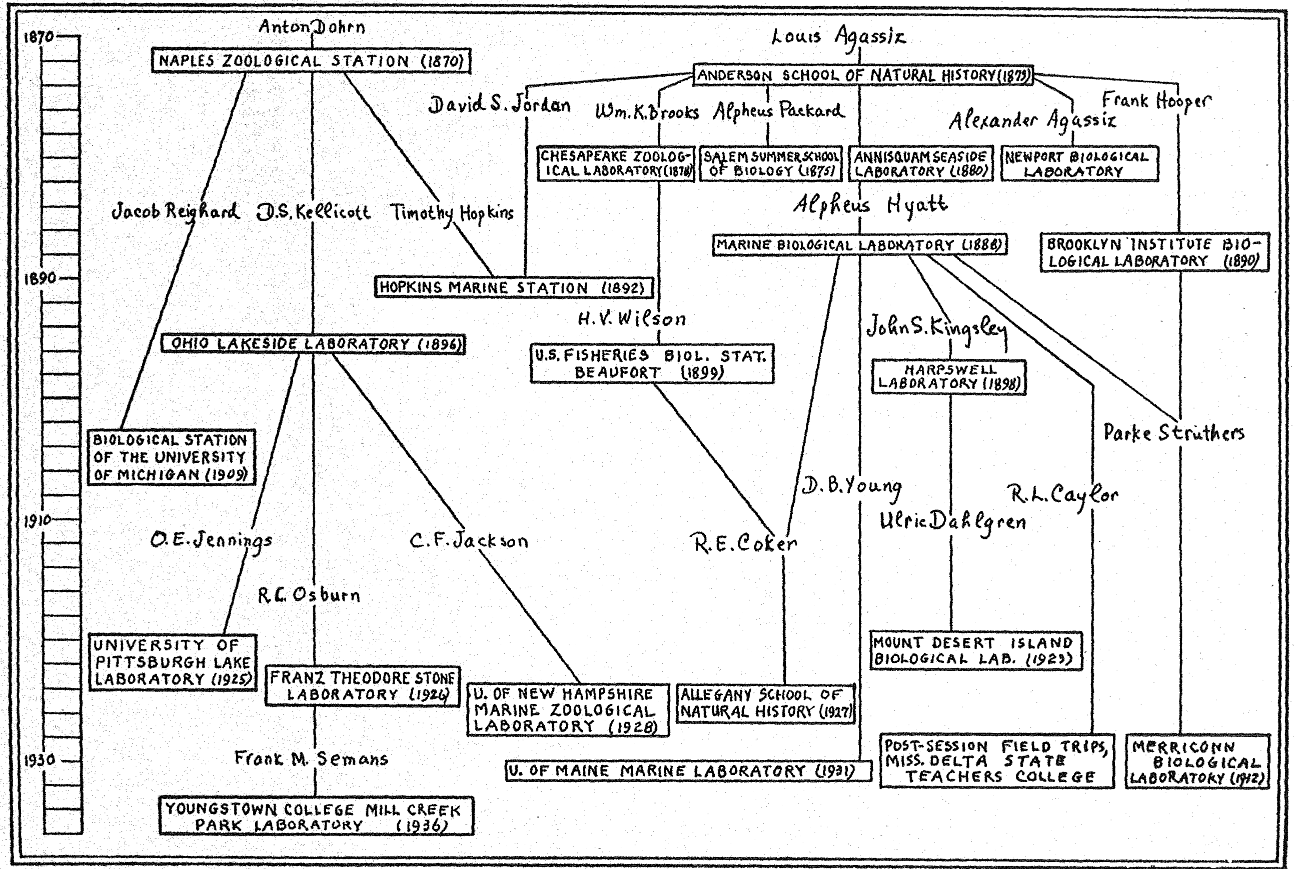
— Indiana —

Winona Lake: **Indiana University Biological Station:** — Habitats available for study include mesophytic deciduous forests, a variety of glacial lakes in various stages of development and decay, and a medium-sized river. Founded in 1895 by Dr. C. H. Eigenmann and now sponsored by Indiana University for research in most phases of fresh water biology and physics. Dr. William E. Ricker directs the work of the station, which is open during June, July, and August. — *Cf.* Science 10:925-29; Lenz 1927; Turtox 1937.

— Iowa —

McGregor: **American Institute of Nature Study:** — Founded in 1918 and now sponsored jointly by the Iowa Conservation Commission and the citizens of McGregor for instruction in nature study. Rev. Glenn W. McMichael is executive director of the institute, which gives a 2-week course in nature study each summer. — *Cf.* Turtox 1937.

Milford: **Iowa Lakeside Laboratory:** — On West Okoboji Lake, of glacial origin and 132 feet deep with a shoreline of 18 miles. Founded in 1909 and now sponsored by a board of managers from several state and federal agencies for the purpose of studying the hydrology and biology of the State of Iowa. Prof. Joseph H. Bodine is



— Genealogy of United States Biological Stations —

director of the laboratory. Research, instructional, and living accommodations are available. Summer courses are given in biology and protozoology. The station is open between the second week in June and the third week in August. — *Cf.* Science 49:466-67; The Biologist 18:114-22; LENZ 1927; Turtox 1937.

— *Louisiana* —

Grand Isle: **Louisiana State University Field Laboratory:** — On an island at the foot of Barataria Bay, west of the mouth of the Mississippi River, with a fine sand beach on the Gulf of Mexico and mud flats and marshes on Barataria Bay. Sponsored by Louisiana State University for instruction and research on Louisiana marine life. Prof. E. H. BEHRE is director of the laboratory, which consists of one building and a tent colony for living accommodations. Summer course work is given in marine zoology for advanced students and biology teachers. The laboratory is open during June and July. — *Cf.* Turtox 1937.

— *Maine* —

Damariscotta: **Audubon Nature Camp:** — Established by the National Audubon Society to offer adult leaders at low cost two-week sessions of ecological study guided by a highly competent and enthusiastic staff of specialists. Mr. CARL W. BUCHHEISTER directs the work of the camp which has an annual budget of $13,000. Facilities are not available to research investigators. — *Cf.* Bird Lore 37:440-41; *Ibid.* 38:3, 36-37, 204-06, 288-92, 348-52; *Ibid.* 39:127-32, 366; Natural History 39:318-28; Nature Magazine 31:212-14; Bird Lore 40:120-22; Turtox 1937.

Lamoine: **University of Maine Marine Laboratory:** — Easy access to the unusually rich flora and fauna of the Gulf of Maine. Sponsored by the University of Maine to offer instruction in marine zoology. Prof. JOSEPH M. MURRAY is director of the laboratory, which is open from July first to September first. There are ample research, instructional, and living accommodations. Course-work is given each summer in marine invertebrate zoology. — *Cf.* Science 87:505; Turtox 1937; VAUGHAN 1937.

Salisbury Cove: **Mount Desert Island Biological Laboratory:** — Accessible to the Acadian fauna, with tides of eleven to fourteen feet. Founded in 1898 as the Harpswell Laboratory by J. S. KINGSLEY and now sponsored by the Mount Desert Island Biological Laboratory, Inc., to establish and maintain a laboratory for biological study and investigation in the State of Maine. Prof. WILLIAM H. COLE is director of the laboratory, which has an annual budget of $8,000. Equipment includes dining hall, darkroom, library, shop, laboratories, and the 30-foot power boat, Dahlgren. Course work is given each summer in invertebrate zoology. The laboratory is open from June fifteenth to September fifteenth. — *Station publication:* Bulletin of the Mount Desert Island Biological Laboratory. — *Cf.* Science 17:983-86; Popular Science Monthly 74:504-13; Int. Rev. Hydrobiol. 4:537-39; Science 41:603-04; Natural History 22:47-55; The Biologist 18:123-26; Science 87:13; *Ibid.* 92:305; Turtox 1937; VAUGHAN 1937.

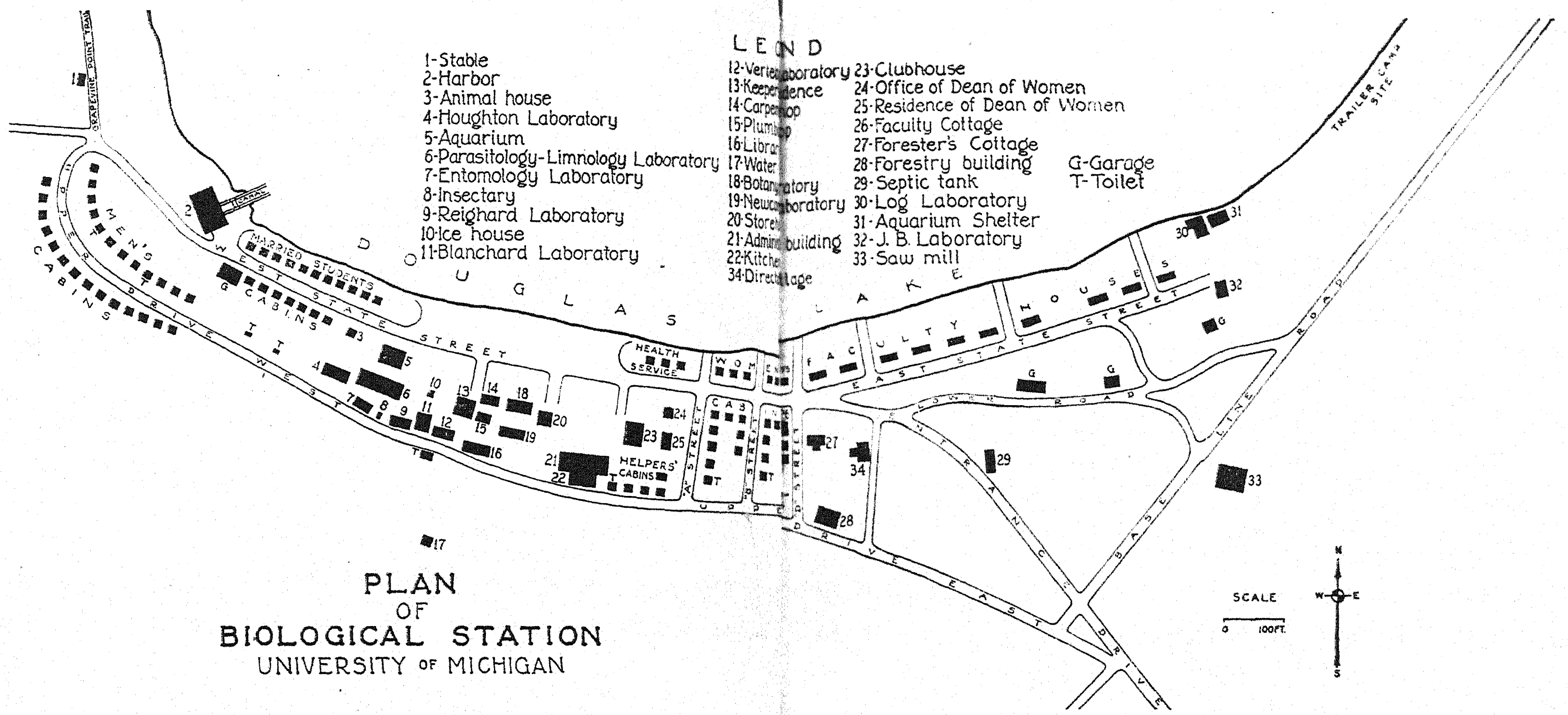
— *Maryland* —

Solomons Island: **Chesapeake Biological Laboratory:** — On the western shore of Chesapeake Bay at the mouth of the Patuxent River. Maintained by the State of Maryland as a research and study center where facts tending toward a fuller appreciation of nature may be gathered and disseminated. Prof. R. V. TRUITT is director of the laboratory, which has an annual budget of $21,000. The two, 3-story brick buildings contain offices, museum, classrooms, library, living accommodations, and many well-equipped laboratories. Several types of boats are available. Summer courses are given in economic zoology, invertebrates, invertebrate embryology, and diatoms. — *Station publications:* Bulletin of the Chesapeake Biological Laboratory; Annual Report. — *Cf.* Science 76:205-06. *Ibid.* 85:513-14; The Biologist 18:127-34; Turtox 1937; VAUGHAN 1937.

— *Massachusetts* —

Plymouth: **Nature Guide School:** — Sponsored by Massachusetts State College to train outdoor leaders. Prof. WILLIAM G. VINAL is director and founder of the school, which offers a 6-week summer course in nature education. — *Cf.* Turtox 1937.

Woods Hole: **Marine Biological Laboratory:** — The fauna and flora are exceptionally rich, there being no muddy river or city sewage to pollute the sea water and



A plan of the grounds and buildings of the Biological Station of the Un of Michigan at Cheboygan Lake, Michigan (*courtesy Univ. of Michigan*).

the shore being varied by necks, points, flats, gutters, bays, and islands. Founded in 1888 as an outgrowth of the Annisquam Seaside Laboratory with Dr. C. O. Whitman as director. It is now an autonomous institution dedicated to the promotion of biological research by supplying investigators with facilities for their work and by offering courses which contribute to the training of investigators. Prof. Charles Packard is director of the laboratory, which maintains a summer staff of 44 professors. The plant includes a 4-story brick laboratory building, four wooden laboratory buildings, three buildings used by the supply department, carpenter shop, mess hall, club house, dwellings, and dormitories. These contain offices, dark rooms, balance rooms, X-ray rooms, auditorium, museum, many private and general laboratories, and a library, the latter containing 52,000 bound volumes, 130,000 reprints, and 1,300 current scientific periodicals. Summer courses are given in protozoology, invertebrate zoology, embryology, physiology, and the morphology and taxonomy of algae. — *Station publications:* Biological Bulletin (1899-); Annual Report. — *Cf.* Science 9:382-83; *Ibid.* 11:20-21, 305-06; *Ibid.* 12:37-38; Pop. Sci. Mon. 42:459-71; Science 7:37-44; *Ibid.* 12:233-44; *Ibid.* 16:529-33, 591-92; Smithsonian Report for 1902:625-32; Science 26:839-42; *Ibid.* 28:509-10; School Science and Mathematics 8:337-40; Nature 84:527-28; Int. Rev. Hydrobiol. 5:583-89; Hearst's Magazine 24:784-86; Outlook 107:767-68; Pop. Sci. Mon. 85:203-04; Science 40:229-32; *Ibid.* 58:142-43, 198; New Republic 36:178-79; Science 59:371-72; *Ibid.* 62:26, 271-80; School and Society 26:592-93; Scientific Monthly 27:186-90; Science 70:208-10; *Ibid.* 80:308; Scientific Monthly 39:377-80; The Biologist 18:135-39; Science 88:402; *Ibid.* 89:57-58; Turtox News 18:93-94; Science 92:213; *Ibid.* 94:206; *Ibid.* 95:14; Sand 1898; Turtox 1937; Frank R. Lillie: The Woods Hole Marine Biological Laboratory. University of Chicago Press, 284 pp., 1944.

Woods Hole: **Woods Hole Oceanographic Institution:** — The nearness of Woods Hole to the transition zone between inshore and oceanic waters, the abruptness of this transition, and the nearness to the continental abyss and ocean basin all make this a particularly favorable headquarters for investigations into many of the basic problems in oceanography that are now engaging scientific attention. Founded in 1930 by an endowment from the Rockefeller Foundation on recommendation of the National Academy of Sciences. It is now an autonomous institution dedicated to the study of oceanography in all its branches. Prof. Columbus Iselin directs the work of the station, which has an annual budget of $110,000. The 4-story building contains a constant temperature room, machine shop, offices, chart room, library, drafting room, darkrooms, and many well-equipped general and individual laboratories. Boats include the 142-foot research ship, Atlantis, and the 40-foot gasoline launch, Asterias. No instruction is offered, but a limited number of visiting investigators may be accommodated, either at the institution or on the Atlantis. — *Station publications:* Papers in Physical Oceanography and Meteorology (1933-); Collected Reprints (1933-); Report for the Year. — *Cf.* Jour. Conseil Int. Explor. Mer 5:226-28; Vaughan 1937; Frank R. Lillie, The Woods Hole Marine Biological Laboratory. University of Chicago Press, pp. 177-91, 1944.

— *Michigan* —

Clear Lake (Montmorency County): **Michigan State College School of Field Biology:** — Sponsored by Michigan State College to train teachers, undergraduates, and graduate students in biology. Prof. Joseph W. Stack directs the work of the school. — *Cf.* Turtox News 18(2):40-42; Turtox 1937.

Cheboygan: **Biological Station of the University of Michigan:** — On the shores of Douglas Lake, in the transition zone between the evergreen coniferous forest region to the north and the deciduous hardwood forest region to the south. Founded in 1909 and now sponsored by the University of Michigan for teaching and research in botany and zoology. Prof. Alfred H. Stockard is director of the station, which has an

annual budget of $16,500. The faculty consists of eleven professors. There is a well-equipped campus with excellent laboratory and living facilities. Each summer courses are given in the taxonomy of fresh-water algae, taxonomy of the bryophytes, systematic botany, plant anatomy, plant ecology, aquatic flowering plants, plant tissue culture and morphogenesis, entomology, ornithology, ichthyology, natural history of invertebrates, herpetology and mammalogy, limnology, and helminthology. The station is open from June twentieth to September first. — *Cf.* School Science and Mathematics 13:411-15; Science 47:381-83; *Ibid.* 49:466-67; Report of the Michigan Academy of Science, Arts and Letters 22:91-99; Science 57:412-13; The Collecting Net 6:169-73; The Biologist 13:130-37; *Ibid.* 18:140-48; LENZ 1927; Turtox 1937.

— Minnesota —

Itasca State Park: **Lake Itasca Forestry and Biological Station:** — On the east shore of Lake Itasca, with a diverse series of habitats furnishing a characteristic succession of plants and animals. Sponsored by the University of Minnesota for the advancement of terrestrial and fresh-water biology by means of promoting and providing opportunities for instruction and research. Prof. T. SCHANZ-HANSEN directs the work of the station. There are ample laboratory and living accommodations. Summer courses are given in field taxonomy (botany), field botany, elementary field ecology, bryophytes and pteridophytes, field research methods in ecology, field dendrology, field mycology, field entomology, wildlife conservation, parasitology, natural history of invertebrates and fishes, protozoology, limnology, and helminthology. The station is open from June to October.

— Mississippi —

Biloxi: **Mississippi Delta State Teachers College Field Botany Trip:** — Sponsored by Mississippi Delta State Teachers College to give instruction in field botany. Prof. R. L. CAYLOR directs the work of the trip, which is housed in a permanent camp on the shore of the Gulf of Mexico. A summer course in field botany is given. — *Cf.* Turtox 1937.

— New Hampshire —

Isles of Shoals: **Isles of Shoals Marine Zoological Laboratory:**—An excellent base for the study of marine life under a variety of conditions. Established in 1928 by Prof. C. FLOYD JACKSON and now directed by him for the University of New Hampshire. There are ample laboratory and living accommodations on the island. Summer courses are given in comparative anatomy, invertebrate zoology, histology-embryology, marine biology, laboratory technique, and the teaching of biology in secondary schools. The laboratory is open only during the summer months. — *Cf.* The Biologist 18:153-59; Turtox 1937; VAUGHAN 1937.

Nelson: **Merriconn Biological Laboratory:** — Founded in 1933 by Prof. PARKE H. STRUTHERS and now maintained by him as a private laboratory open to teachers and advanced students who wish to devote a part of the summer to increase their professional background and investigations in the field of biology. Laboratory and living accommodations are available. Summer courses are given in comparative anatomy, field zoology, and nature training. The laboratory is open to independent investigators from June fifteenth to September fifteenth. — *Cf.* The Biologist 18:111-13; Turtox 1937.

North Woodstock: **New Hampshire Nature Camp:** — In a high mountain valley about 1,800 feet above sea level. An autonomous institution under the sponsorship of Mr. LAWRENCE J. WEBSTER to train teachers and others in nature study and in various methods of imparting this knowledge to others. Dr. JARVIS B. HADLEY directs the work of the camp, which offers limited facilities to investigators. — *Cf.* Turtox 1937.

— New Mexico —

Las Vegas: **Biology Field Courses of Texas Technological College:** — At an altitude of 8,000 feet in a heavily timbered valley surrounded by rather high mountains and mesas. Founded in 1934 and sponsored by Texas Technological College to teach undergraduates biology. Dr. R. A. STUDHALTER is director of the station. Summer course work is given in general biology, although there are no facilities for investigators. — *Cf.* Turtox 1937.

— New York —

Cold Spring Harbor (Long Island): **Biological Laboratory of the Long Island Biological Association:** — The harbor is not exposed to the surf of Long Island Sound, the result being that marine animals and plants grow near the laboratory in great numbers. Founded in 1890 by Prof. Franklin W. Hooper with Dr. Bashford Dean as director. The laboratory is now sponsored by an autonomous institution, the Long Island Biological Association, with an annual budget of about $25,000. Dr. M. Demerec is director of the laboratory. The equipment includes technical shops, library, animal rooms, many kinds of laboratories, dining room, and dormitories. Summer courses were given in experimental surgery, experimental endocrinology, and marine and fresh water zoology. Each summer the laboratory invites a group of chemists, mathematicians, physicists, and biologists to take part in a 5-week symposium in some selected aspect of quantitative biology. The laboratory closely cooperates with the adjacent Dept. of Genetics of the Carnegie Institution. — *Station publications:* Cold Spring Harbor Symposia on Quantitative Biology (1933-); Annual Report. — *Cf.* Int. Rev. Hydrobiol. 4:223-26; Science 59:332; *Ibid.* 63:419; Rivista di Biologia 12:150-58; Science 88: suppl. 10; The Collecting Net 15(1):1, 3-4; Sand 1898; Turtox 1937; Science 99:395-397.

[*Quaker Bridge:* **Allegany School of Natural History:**—After a short but influential existence, this institution was abandoned permanently in 1941. — *Cf.* Science 65:201; Playground 21:170; School and Society 27:598-601; *Ibid.* 28:106; *Ibid.* 31:197-98; Elementary School Journal 29:569-70; Bird Lore 35:125-28; School Science and Mathematics 38:67-71.]

— North Carolina —

Beaufort: **Duke University Marine Station:** — Established by Duke University to study marine biology. Prof. A. S. Pearse is director. There are three dormitories, a laboratory-building, a boat-house, a dining hall, and the caretaker's residence. Summer courses are given in algae, marine zoology, plant ecology, parasitology, and invertebrate zoology. — *Cf.* Science 87:454.

Beaufort: **Fisheries Biological Station at Beaufort, North Carolina:** — Easily accessible are a large variety of aquatic animals and plants, including those living in the open ocean, in brackish water, and in fresh water. Established in 1899 and now sponsored by the United States Fish and Wildlife Service for investigations of marine biology. Dr. Herbert F. Prytherch is director of the station, which has an annual budget of about $17,000. The eight buildings contain a marine aquarium, museum, dormitory rooms, library, and several types of laboratories. Available boats include a 46-foot cruiser, a 33-foot boat, and an 18-foot outboard motorboat. — *Cf.* Int. Rev. Hydrobiol. 7:122-26; Science 69:547-49; U. S. Bureau of Fisheries Economic Circular 72; Magrini 1927; Turtox 1937; Vaughan 1937.

Highlands: **Highlands Museum and Biological Laboratory:** — Situated abreast of the Blue Ridge at an elevation of 4,000 feet. Established in 1927 and now an autonomous institution to promote, conduct, and maintain biological research in the southern Appalachian Mountains. Prof. W. C. Coker directs the work of the laboratory, which is open during July and August to investigators. — *Station publication:* Publications of the Highlands Museum and Biological Laboratory (1930-). — *Cf.* Jour. Elisha Mitchell Scientific Society 49:35; Mycologia 25:330-31.

— Ohio —

Put-in-Bay: **Franz Theodore Stone Laboratory:** — On an island in Lake Erie. Established at Sandusky in 1896 and moved to present site in 1918. Sponsored by Ohio State University in coöperation with the Ohio Division of Conservation and Natural Resources for the development of biological research and the application of its results to the welfare of humanity. Prof. Thomas H. Langlois directs the work of the station, which maintains a year-round scientific staff of seven persons. There is a well-equipped, 3-story laboratory building and also living accommodations. Summer courses are given in plant taxonomy, plant ecology, fresh water algae, higher aquatic plants, physiology of aquatic plants, advanced entomology, aquatic entomology, climatology, invertebrate zoology, aquiculture, ichthyology, animal parasitology, field

biology, advanced ornithology, herpetology, comparative physiology, and physiology of fishes. — *Station publication:* Contributions from the Franz Theodore Stone Laboratory.— *Cf.* Jour. Applied Micro. 6:2550-553; Science 49:466-69; The Biologist 18:149-52; Science 87:315-16; Turtox 1937.

— *Oregon* —

Coos Head: **Oregon Institute of Marine Biology:** — At the entrance to Coos Bay which contains wide stretches of tide-flats interspersed with sandy and rocky beaches. Sponsored by the Oregon State System of Higher Education for instruction and research in marine biology. Prof. Earl L. Packard is director. Summer course work is given in field zoology, biology of fishes, embryology of marine invertebrates, invertebrate zoology, taxonomy and ecology of marine algae, morphology of marine algae, systematic botany, paleobiology, and biological science survey. The Institute is open during June and July. — *Cf.* Science 85:240; Vaughan 1934; Vaughan 1937.

— *Pennsylvania* —

Bristol Township (Bucks County): **Effingham B. Morris Biological Farm:** — Sponsored by the Wistar Institute of Anatomy and Biology with Dr. Edmond J. Farris as executive director. Laboratory and living accommodations are available to qualified investigators. — *Cf.* Bull. Wistar Institute of Anatomy and Biology 8:1-31.

Huntingdon County: **Pennsylvania State College Nature Camp:** — Founded in 1923 by Prof. George R. Green and now sponsored by Pennsylvania State College to provide outdoor training and experience under expert field naturalists and to satisfy the demands of teachers and nature lovers for practical nature study and science field work. Ample living and laboratory facilities are available for summer course and research work in nature education. — *Cf.* Turtox 1937.

Presque Isle Peninsula (Erie County): **University of Pittsburgh Lake Laboratory:** — A peninsula in Lake Erie, with a continuous ecological series of ponds and marshes. Sponsored by the University of Pittsburgh as a field station for research and undergraduate instruction. Prof. O. E. Jennings is director of the laboratory, which is housed in a small, wooden building. Summer courses are given in field botany, nature study, field zoology, and entomology. The laboratory is open to investigators from the last week of June to the end of August. — *Cf.* Turtox 1937.

— *Rhode Island* —

Narragansett: **Narragansett Laboratory of Rhode Island State College:** — On the shore of Narragansett Bay, in which the winter fauna is predominately boreal and the summer fauna is Virginian with a periodic influx of open ocean and gulf stream forms in late summer. Sponsored by the Rhode Island Division of Fish and Game and Rhode Island State College to offer facilities for marine research. Charles J. Fish directs the work of the laboratory, which contains good scientific equipment. The laboratory is open from June fifteenth to September first to investigators. — *Cf.* Vaughan 1937.

— *South Dakota* —

Nemo: **South Dakota State College Botany Summer Camp:** — In the heart of the Black Hills with a diversity of biological habitats. Sponsored by the Botany Department of South Dakota State College for instruction and research in the taxonomy and ecology of the Black Hills flora. Prof. Leon C. Snyder is director of the Camp, which is erected on land belonging to the National Forest Service. A summer course is given in the taxonomy of the Black Hills flora. Investigators may work at the camp between the second week of June and the third week of July.

Waubay: **Lake Enemy Swim Biological Station:** — Sponsored by Northern State Teachers College to offer the best possible opportunity to teachers, students, and investigators for the study and investigation of problems of the life sciences. Prof. Sidney R. Lipscomb directs the work of the station, which contains dormitories, dining hall, and a central laboratory building. Summer courses are given in natural science, animal biology, taxonomy of the flowering plants, plant anatomy, eugenics, and animal histology. No facilities are available to investigators. — *Cf.* Turtox 1937.

— Tennessee —

Reelfoot Lake: **Reelfoot Lake Biological Station:** — On the banks of Reelfoot Lake which was formed by an earthquake in 1815 and with the areas, therefore, definitely dated. Sponsored by the Tennessee Academy of Science to furnish opportunity for research to advanced investigators. Prof. Clinton L. Baker is director of the station, which consists of a well-equipped laboratory building. The station is open to investigators from June first to September fifteenth. — *Station publication:* Report of the Reelfoot Lake Biological Station (1937-). — *Cf.* Jour. Tenn. Acad. Sci. 1:11-15; Science 76:208; Turtox 1937.

— Utah —

Utah Lake: **Brigham Young University Lakeside Biological Laboratory:** — On a shallow, fresh-water lake with an area of about 75,000 acres. Sponsored by Brigham Young University to study the ecology of the flora and fauna of the lake. Prof. Vasco M. Tanner directs the work of the laboratory, which consists of one laboratory building. — *Cf.* Turtox 1937.

— Vermont —

Newfane: **Summer School of Bryology:** — The hills of southern Vermont offer a moss and hepatic flora which is unusually abundant. Sponsored by the Long Island Biological Association to instruct students wishing to gain proficiency in the study of mosses. Prof. A. J. Grout directs the work of the school, which contains a library, laboratory space, and a herbarium of 30,000 specimens. Summer course work of an informal nature is offered in bryology. The school is open to investigators from June to October. — *Station publication:* The Moss Flora of North America, North of Mexico.

Randolph: **Green Mountain Nature Camp:** — An autonomous institution directed by M. Elsie Osgood to combine an invigorating, but restful vacation in the open with a chance to study nature first-hand. Informal course work is given during the summer in nature study. Research facilities are not available.

— Virginia —

Chester: **Virginia Natural History Institute Nature Leaders Training Course:** — Founded in 1940 under the initiative of the National Recreation Association to provide training and practical field experience to leaders and prospective leaders for park, recreational, and camping agencies and educational institutions. Reynold E. Carlson is director of the Course, which is given during the summer. Research facilities are not available.

Mountain Lake: **Mountain Lake Biological Station:** — At an altitude of almost 4,000 feet, and within a radius of five miles collections can be made from places with a difference of 2,500 feet in altitude. Founded in 1929 and now sponsored by the University of Virginia to offer facilities for graduate instruction and research in the biological field to qualified students, teachers, and investigators from the Southern States. Prof. Ivey F. Lewis is director of the station, which has an annual budget of $11,000. Equipment includes a library, herbarium, museum, auditorium, darkrooms, culture rooms, offices, classrooms, dining hall, living cottages, dormitories, and trucks. Summer courses are given in the morphology of seed plants, plant taxonomy, phycology, mycology, protozoology, cell morphology, experimental morphogenesis, and hydrobiology. The station is open to investigators from June fifteenth to September first.— Cf. Science 80:112-13; Life 9:49-51; Turtox 1937.

Yorktown: **Virginia Fisheries Laboratory:** — Within easy reach of the James River and only seven miles from the deeper waters of Chesapeake Bay. Established recently by the College of William and Mary and the Commission of Fisheries in Virginia in order to conduct investigations and give instruction in aquatic biology and conservation. Dr. Curtis L. Newcombe is director of the laboratory. While classwork is done mainly at Williamsburg, research requiring running sea-water is conducted at Yorktown. The 45-foot Agnes Hope is used for off-shore studies.

— Washington —

College Place: **Walla Walla College Field Nature School:** — Sponsored by Walla Walla College to afford an opportunty for students interested in nature to learn to

understand nature from first-hand observation. An itinerant school, pupils travelling every other summer 800 miles from the Blue Mountains in eastern Oregon down the Columbia River to Mount Rainier. Prof. HAROLD W. CLARK is director of the school, which does not offer research facilities.

Friday Harbor: **University of Washington Oceanographic Laboratories:** — The inland waters of the San Juan Archipelago and adjacent territory have a great variety and wealth of marine flora and fauna. Founded in 1904 and now sponsored by the University of Washington for independent research, directed research, and seminar and formal courses in the different phases of oceanography. Prof. THOMAS G. THOMPSON is director of the laboratories, which have an annual budget of $15,000. The equipment includes seven laboratory buildings, stockroom, dining hall, living tents, cantilever pier, 50-foot power boat, Medea, and the 75-foot research vessel, Catalyst. There is also a 3-story laboratory building at Seattle. Summer courses are given in the physiology of bacteria, marine plants, physiology of marine plants, phytoplankton, oceanographic chemistry, physical oceanography, biochemistry of marine life, oceanographic meteorology advanced invertebrate embryology, and advanced invertebrate zoology. Research facilities are available during June, July, and August. — *Station publications:* University of Washington Publications in Oceanography (1932-); University of Washington Publications in Oceanography, Supplementary Series (1931-). — *Cf.* Pop. Sci. Mon. 86:223-32; Science 69:331-32; Natural History 36:73-80; Jour. Chemical Education 13:203-09; The Biologist 18:160-70; MAGRINI 1927; VAUGHAN 1934; Turtox 1937; VAUGHAN 1937.

Seattle: **University of Washington Field Course in Botany:** — An itinerant station sponsored by the University of Washington to acquaint students with the vegetation of North America and to give University of Washington botanists better access to the less well-known botanical regions of that area. Dr. C. LEO HITCHCOCK directs the work of this field course, which offers formal work in plant taxonomy during the summer. Independent investigators may accompany the course.

— West Virginia —

Morgantown: **West Virginia University Biological Expedition:** — An itinerant station sponsored by West Virginia University to complement the ordinary biological courses with outdoor laboratory work. Prof. P. D. STRAUSBAUGH directs the work of the expedition, which offers summer courses in botany and zoology. A limited number of investigators may be accommodated. — *Cf.* the Biologist 18:171-76; Turtox 1937.

Oglebay Park: **Oglebay Institute Nature Leaders Training School:** — Sponsored jointly by Oglebay Institute, Wheeling Park Commission, and West Virginia University for practical instruction in the field for nature teachers and others. Mr. A. B. BROOKS directs the work of this school, which offers a series of summer courses in natural history. Research facilities are not available.

— Wisconsin —

Long Lake: **Lost Lake Conservation Camp:** — Sponsored by the nine State Teachers Colleges of Wisconsin and the U. S. Forest Service to give teachers and prospective teachers an opportunity to gain a practical knowledge of conservation and an extensive biological background which is essential for this. Prof. THORPE LANGLEY directs the work of the camp, which makes use of former C.C.C. lodges. Summer courses are given in field zoology, field botany, nature study, and conservation. Research facilities are not available.

Trout Lake: **Trout Lake Limnological Laboratory:** — Several hundred lakes are found within a radius of 25 miles from the laboratory. Sponsored by the University of Wisconsin and the Wisconsin Conservation Department to study the physics, chemistry, and biology of Wisconsin lakes. Prof. CHANCEY JUDAY is director of the laboratory, which has an annual budget of $15,000. There are ample living and laboratory facilities. No course work is given, but independent investigators may work at the laboratory from June through September. — *Cf.* Trans. Wis. Acad. Sci., Arts, and Letters 25:337-52; The Biologist 18:177-82; Turtox 1937.

Williams Bay: **Geneva Lake Summer School of Natural Science:** — An autonomous

institution dedicated to correlate theory and practice by giving students an opportunity for personal observation of the geological formations, plants, and animals of southern Wisconsin. Dr. ARTHUR D. HASLER is director of the School, which has good living and field laboratory facilities. Summer courses are given in plant ecology, advanced plant taxonomy, glacial geology, field geology, field zoology, limnology, survey of astronomy, and the teaching of science. Research facilities are available during the summer months. — *Cf.* Turtox 1937.

— Wyoming —

Centennial: **University of Wyoming Science Summer Camp:** — In the subalpine zone of the Medicine Bow National Forest at an altitude of 9,500 feet. Founded in 1923 and now sponsored by the University of Wyoming for field instruction and research in botany, geology, and zoology. Prof. S. H. KNIGHT is director of the camp. The equipment includes a central log lodge, four laboratory buildings, and forty lodging cabins. Summer courses are given in fresh-water algae, taxonomy of vascular plants, ecology, field and laboratory general botany, Wyoming birds, aquatic zoology, elementary field and laboratory zoology, elementary field course in geology, and advanced field geology. The camp is open to investigators from June fifteenth to August first. — *Cf.* The Biologist 18:183-89; Turtox 1937.

Jackson: **Rocky Mountain Biological Station of the University of Michigan:** — In a rugged mountain area, near the continental watershed. Sponsored by the University of Michigan Summer Session to conduct a general plant survey of the region and explore the possibilities of the region for biological study and research. Prof. LEWIS E. WEHMEYER is director of the station, which makes use of the summer engineering camp of the University of Michigan. No formal courses are given, but research may be undertaken during July and August.

— VENEZUELA —

Rancho Grande (Maracay): **Biological Station of the New York Zoological Society:** — This has recently been established. Dr. WILLIAM BEEBE writes (May 29, 1945): "As to the permanence of my Rancho Grande, I am only able to say that it looks as if it might be continued. I shall spend ten months next year here, and both the Venezuelan Government and the Creole People as well as our Zoological Society are anxious to have it kept up. I hope to get some of the native scientists trained to carry it on. I should say there is a very fair chance of its being carried on."

— YUGOSLAVIA —

Rab: **Biological Station of the Czechoslovak Society for a Marine Biological Station:**—Sponsored by the Czechoslovak Society for a Marine Biological Station to enable Czechoslovakian biologists to work in sea biology. There is one building which contains laboratory facilities. — *Station publication:* Travaux (1933-). — *Cf.* VAUGHAN 1937.

Split: **Oceanografski Institut:** — Sponsored by the Government of Yugoslavia for researches in oceanography and biology and instruction for students. Prof. A. ERCEGOVIĆ directs the work of the institute. Equipment includes a public aquarium, library, living accommodations, and 25 laboratories. Courses are given in marine biology. — *Station publications:* Acta Adriatica; Annual Report. — *Cf.* VAUGHAN 1937.

Struga: **Die Hydrobiologische Abteilung der Antimalariastation zu Struga:** — *Cf.* LENZ 1927.

Crna Mlaka (Zdenčina, Kroatien): **Teichwirtschaftliche Versuchsstation:** — *Cf.* LENZ 1927.

After this booklet had been completed I received word of the publication of an extensive biography of ANTON DOHRN *by* THEODOR HEUSS (Berlin und Zürich: Atlantis-Verlag, pp. 319, 1940). — This is a very fine volume, of great interest to all interested in the development and methods of organization of biological stations.


STB

INTERNATIONAL RELATIONS *in* SCIENCE

a review of their aims and methods in the past and in the future

by

WALTER B. CANNON, M.D., Sc.D., LL.D.

Chairman, Div. of Foreign Relations, National (U.S.) Research Council; Foreign Secretary, National (U.S.) Academy of Sciences; Emeritus Professor of Physiology, Harvard University; etc.

and

RICHARD M. FIELD, Ph.D.

U.S. Representative, Committee on Science and its Social Relations, Int. Council of Scientific Unions; Member, Div. of Foreign Relations, Nat. (U.S.) Research Council; Director, Summer School of Geology and Natural Resources, Princeton University.

In 1813, when France and England were fighting each other, Sir Humphrey Davy visited Paris, was awarded a gold medal by the Académie des Sciences, *and elected a corresponding member. Such amenities have long since vanished. (Report of the Division of Foreign Relations, Nat. (U.S.) Research Council, 1943).*

EDITOR'S FOREWORD

Although parts of the following interesting report are not directly concerned with biology and agriculture, its general aspects, considerations, and conclusions are of great importance from our point of view. As soon as I had seen the original mimeographed version of Dr. CANNON *and Dr.* FIELD'S *memorandum, I asked them for permission to publish this document, which incorporates the views and experience of so many distinguished workers, in the field of international scientific relations, in a most useful way.*

Permission for reproduction was not only gladly given, but Dr. RICHARD M. FIELD, *the junior author, undertook to rewrite the document entirely, and the editors of* CHRONICA BOTANICA *take great pleasure in printing this version of the report in their journal.*

We have reported in the past in detail about most of the organizations with which this report deals, in the section "International Relations" of CHRONICA I *seq. Now that the war is over, the future of international relations in science — their aims, scope, and possibilities — are again much in our mind (although they have of course never been out of our thoughts during the war years). In the past* CHRONICA BOTANICA *has given relatively more space to international relations in its field than probably any other scientific journal. We will continue to do so in the future and are happy to open the series of numbers of* CHRONICA BOTANICA, *devoted to the study and promotion of international relations in science in the post-war world, with Dr.* FIELD *and Dr.* CANNON'S *memorandum.*

Extra copies of the report may be obtained, without charge, from the CHRONICA BOTANICA CO., *Waltham, Mass., or the Division of Foreign Relations of the National (U.S.) Research Council, 2101 Constitution Avenue, Washington, D. C., or the Secretary of the International Council of Scientific Unions (Dr.* F. J. M. STRATTON, *Gonville and Caius College, Cambridge, England), or the Secretary of the International Union of Biological Sciences (Dr.* M. J. SIRKS, *University of Groningen, the Netherlands).*

—CONTENTS—

Part I

INTRODUCTION: REASONS AND AUTHORITY FOR THE MEMORANDUM, INCLUDING THE METHODS USED IN OBTAINING THE ESSENTIAL DATA

Introduction: — This Memorandum has been prepared for the Division of Foreign Relations of the National Research Council. Copies have been requested by the Division of International Conferences of the United States Department of State, by non-American officers of the "Unions", and by other agencies concerned with the international aspects of science, technology, and their social relations, including the International Council of Scientific Unions. This Memorandum will not attempt to define science, or scientific method, except in terms of the seven existing technical divisions of the National Research Council of the United States, and the interrelation of their problems with those of the Division of Foreign Relations. These seven technical divisions of the National Research Council are: Division of Physical Sciences, Division of Engineering and Industrial Research, Division of Chemistry and Chemical Technology, Division of Geology and Geography, Division of Medical Sciences, Division of Biology and Agriculture, and Division of Anthropology and Psychology. If economics and politics are not recognized in this Memorandum as sciences, it is because they are not so recognized by the National Research Council of the United States nor by any National Committee of any international scientific union. The implications, however, of the responsibilities of scientists to society are suggested not only in the general organization of the N. R. C., but also by the American representative of the Committee on Science and its Social Relations of the International Council of Scientific Unions. It should also be noted that American officers of International Scientific Unions represent their Unions in the Division of Foreign Relations. The ultimate authority for the preparation of this Memorandum is through the Division of Foreign Relations of the United States National Research Council according to paragraphs 3, 4, and 6 of the Executive Order No. 2859, May 11, 1918. (*See* p. 284.)

This Memorandum is in no way directly connected with science and the winning of the war; it is, however, concerned with science and the winning of the peace. For quite obvious reasons no truly international organization has been, or ever could be, created for winning wars. We are not aware of the full degree of Axis effort and efficiency in scientific coöperation for winning the war. We are aware of our own national scientific organizations and British organizations, including their coöperation, for the same purpose. The Division of Foreign Relations of the National Research Council is particularly concerned, because of its full responsibilities, in any and all scientific and technological contributions to winning and maintaining

a reasonable comity among nations, including the about-to-be-liberated areas and those of their defeated invaders.

War is a great stimulus to national, and to limited international, coöperative scientific research in most, if not all, of the applied sciences. On the other hand, this stimulus though greatly increasing scientific effort necessarily has uneconomic, unsocial and inhumane implications. It is only in times of relative peace between nations that the fundamental and cumulative effects of the impact of science and technology on human society can be studied by the scientific method, without interference of ideological propaganda and wishful thinking associated with war time economics and war time politics. Similar, though less intense, restrictions interfere even in times of peace with the complete interchange of scientific techniques for the benefit of the people of all nations. These restrictions, therefore, also tend to interfere in all international scientific and technological gatherings, particularly when the scientific personnel act primarily as delegates of their national institutions rather than as scientists representative of their countrymen. Only continuous effort will accelerate international coöperation in fundamental science, or in scientific research beneficial to all men, and inimical to none.

This Memorandum is, therefore, concerned with the continuity of international coöperative research, and particularly with the accomplishments of international scientific organizations during the rise and fall of the Treaty of Versailles and its geopolitical implement, the League of Nations. It is significant that during this period, 1918 to 1939, excellent machinery was developed for the comity of nations through science. This machinery was sponsored by forty-two nations, including all the present belligerents, neutrals and invaded countries with the exception of Russia, and, at times, of Italy. It should be further noted that at no time were the scientific representatives of the United States in any way seriously embarrassed in their deliberations or responsibilities by the fact that their country had helped to plan the League of Nations but refused to join it.

"What we need to-day, then, is fundamentally *an attempt to combine the methods which the world of science has spontaneously worked out for itself in periods of peace, with those which the nations have had to work out under the stress of war.* The methods of peace time have included the periodical International Congresses in the various sciences, at which numerous lectures and demonstrations are given; and the International Unions or permanent Bureaux which function continuously in some sciences. The methods of war time involve the Science Coöperation Offices which have been established in both World Wars in London, Washington, Paris, Chungking, etc. None of this machinery ought to be scrapped. The problem is to weld it into a satisfactory functioning system." (Joseph Needham, December, 1944.)

The question may be posed as to the advisability of the scientists of the world experimenting with international organizations, or participating in international scientific meetings which are not initiated by one or more governments, but by the scientists themselves.

The Russian government is the only great power which appears to have carefully considered the importance of this question, and for reasons which are worth immediate and careful attention by American and British scientists and by their national institutions. (*See* p. 285.)

The least sporadic and opportunist of international scientific organizations have been the congresses and unions; of the two the congresses are the older. The history of international congresses, committees, and other forms of organized international coöperation goes back to the second half of the last century. *It is essential that those scientists who are today (either independently or as advisers to their governments) planning post-war research and education become familiar with previous efforts in their field and related fields. They should do this in order that they may evaluate the past experience of others before attempting to define the frame work of new or duplicating organizations.*

Certain departments of science and technology are represented by the congresses, and others by the unions; but some departments of science are represented by both congresses and unions. For instance, in the case of the biological sciences, the Union and the Congress are closely related; in the case of the earth sciences, the International Union of Geodesy and Geophysics overlaps particularly the functions of the International Geological Congress; but there has been no particular liaison between these international organizations either as to agenda or meetings, except through a commission of the International Union of Geodesy and Geophysics.

The scientific congresses do not function between meetings, and, at times, are more subject to political opportunism, as in the case of the last or Eighth American Scientific Congress. The mechanism of the International Scientific Unions include *Bureaux* which are expected to function continuously between meetings; and the Unions are financed by all countries which adhere to one, or more, of them. The control of each Union, however, is through its Bureau: whose officers are elected at a General International Assembly. Each International Scientific Union also has its national committees which represent the affairs of each Union on a National Research Council, National Academy, National Society, or analogous National Scientific Council. Finally, there is an International Council of Scientific Unions whose primary function is the coordination of all science particularly for the promotion of international friendship through competitive but sympathetic coöperation.

In April, 1937, the Committee on Science and its Social Relations (C. S. S. R.) was created "pour étudier le progrès, les répercussions et les nouvelles directions dans les sciences mécaniques, physiques, chimiques et biologiques, tout spécialement dans le but de dresser un tableau de la pensée humaine en ce qui concerne le développement du panorama scientifique mondial, *et la signification sociale des applications de la science.*"

The last report (1939) of the Council of International Scientific Unions was through its Committee on Science and its Social Relations. This report consists of the original data supplied by each national representative of the I. C. S. U. Unfortunately, the United States never submitted its report. Of particular significance at the present time (1944) are the reports from Poland, Estonia, Latvia, Canada, and Great Britain.

This digest of the organizations, methods, and activities of the international scientific unions is predicated on the assumption that any adverse criticism is probably equally, if not more, applicable to other existing national and quasi-international organizations.

Dependent upon the character, rather than upon the profession, of their officers certain of the International Unions have been more effective than others. On the whole, however, the activities of the International Scientific Unions from 1918 to 1945 warrant the recent statement by an executive officer of one of America's leading technical, social, and philanthropic organizations: "If there is any nucleus of international goodwill and understanding left in the world, it resides, I think, in scientific personnel. They will be the first to mend the broken wires of communication, and I hope this time all the world will realize, whether we like it or not, we have to live together on a globe which science has made too small for war." (T. B. Appleget, July 11, 1944).

At the April meeting of the Executive Committee of the Division of Foreign Relations, 1943, there was some discussion of the war time activities of the International Scientific Unions. This discussion was precipitated by the difference in the reports of the American officers and their adjutants. The relative activity or inactivity of each American officer did not seem to be conditioned entirely by the department of science which his union represented nor by the fact that he and his colleagues were particularly burdened by their contributions to the war effort. After some informal discussion it was decided to circularize all available officers, or adjutants, of the International Scientific Unions and International Scientific Congresses. This was done in the form of a questionnaire which was finally formulated by three members of the Executive Committee, Division of Foreign Relations, N. R. C., and jointly transmitted by the Chairman of the Division of Foreign Relations and the N. R. C. representative of the Committee on Science and its Social Relations, International Council of Scientific Unions. This questionnaire was issued during the last week in March, 1944.

Questions:—

I. To what extent has there been interchange of information in your field between your country and foreign countries, other than for war purposes, during the past two years? By:

1. Officers and personnel of your International Scientific Union (Congress or Society).
2. National societies.
3. National educational and research organizations.
4. Personal correspondence.

II. Are members of your Union (Congress or Society) planning an international meeting as soon as world conditions will permit?

1. If so: Why and where?
2. If not: Why not?

III. If your Union (Congress or Society) through its national committees or commissions is still active, do your activities include:

1. Interim reports.
2. Preparation for resumption of your international journal or transactions.
3. Continued government financing through one, or more, of the national committees.
4. Plans for international interchange of technical publications with the allied and neutral countries. Also, plans for interchange with axis occupied countries after the war.

IV. Have the officers of your Union (Congress or Society) kept in touch with the officers and personnel of other Unions (Congresses)? If so, with which countries, and what was the nature or general purpose of the correspondence?

V. Are there specific scientific projects, requiring international cooperation, in which your Union (Congress or Society) could participate, with essentially equal advantage to all cooperating countries?

VI. Does your experience lead you to believe that post-war international cooperation in science and education could best be served by other organizations than international scientific Unions or Congresses. If so, why?

Part II

SCOPE AND AREA OF THE REPLIES TO THE QUESTIONNAIRE

I. **International Union of Pure and Applied Physics.** — According to L. P. EISENHART, Chairman, Division of Physical Sciences, N. R. C., and Representative, American Section of the Union, Division of Foreign Relations, N. R. C.: "No international activities of the 'Union' to report." (April 25, 1944). The latest information regarding the activities of the Bureau is contained in a letter from M. SIEGBAHN to the Executive Secretary, N. R. C. (Oct. 3, 1941). The following international scientific organizations may be classified with (related to) applied physics or engineering:

A. **International Bureau of Weights and Measures.** — According to L. J. BRIGGS, Representative, American Section I. B. W. M. Also some information which, for political reasons, cannot be quoted.

B. **International Electrical Commission: International Commission on Illumination.** — According to E. C. CRITTENDEN, Representative, American National Committee I. E. C. and I. C. I.

C. **International Scientific Radio Union.** — According to J. H. DELLINGER, Chairman, American Section, I. S. R. U. Also further information by others, marked 'restricted', and, therefore, may not be quoted for war reasons.

D. **International Mathematical Congress.** — According to R. G. D. RICHARDSON, Secretary.

II. **International Union of Chemistry.** — According to M. T. BOGERT, President.

III. **International Union of Biological Sciences.** — According to E. D. MERRILL, President. Also related:

A. **International Paleontological Union.** — According to B. F. HOWELL, Secretary. Also, E. DORF, Chairman, Committee on Paleobotany, N. R. C. Also, G. L. JEPSPN, Section on Paleontology, N. R. C.

B. **Botanical Section, I. U. B. S.** — According to F. VERDOORN, Hon. Secretary.

C. **International Medical Organizations.** — According to W. B. CANNON, Chairman, Division of Foreign Relations, and Foreign Secretary, U. S. National Academy of Sciences.

D. **International Aspects of Horticulture.** — According to American Horticultural Union, E. L. D. Seymour, Vice President.

IV. **International Geographical Union.** — According to C. F. Arden-Close, First Vice President. Also, J. K. Wright, Chairman, U. S. Nat. Com. I. G. U.

V. **International Geological Congress** (There is no international geological union). — According to W. F. T. McLintock, General Secretary, I. G. C., R. M. Field, Foreign Correspondent, Geological Society of London, C. H. Behre, Secretary, Society of Economic Geologists, and I. H. Cram, President, American Association of Petroleum Geologists.

VI. **International Union of Geodesy and Geophysics.** — According to H. St. J. Winterbotham, General Secretary, I. U. G. G.; J. A. Fleming, Vice President, I. U. G. G. and General Secretary, American Section, I. U. G. G. Also, N. J. Ogilvie, Canadian National Committee, I. U. G. G., and R. M. Field, Chairman, Central Commission on Continental and Oceanic Structure, I. U. G. G.

A. **International Association of Geodesy.** — According to W. D. Lambert, Vice President and acting President.

B. **International Association of Seismology.** — According to N. H. Heck, President, and J. B. Macelwane, Chairman, American National Committee, Pacific Seismology.

C. **International Association of Meteorology.** — According to S. Chapman, President.

D. **International Association of Magnetism (Geomagnetism) and Electricity.** — According to J. A. Fleming, President, and S. Chapman, Vice President.

E. **International Association of Oceanography.** — According to P. C. Whitney and T. G. Thompson, N. R. C. Representatives, Division of Foreign Relations. See also Committee on Continental and Oceanic Structure, I. U. G. G.

F. **International Association of Vulcanology (also Volcanology).** — According to J. A. Jaggar, Vice President, and J. E. Richey, Emergency President. See also Committee on Continental and Oceanic Structure, I. U. G. G.

G. **International Association of Scientific Hydrology.** — According to O. Lütschg, President (O. E. Meinzer, U. S. Representative).

H. **International Commission on Snow and Glaciers.** — (I. A. S. H.) According to J. E. Church, President.

I. **International Commission on Subterranean Water.** — (I. A. S. H.) According to J. E. Church, President.

J. **International Commission on Continental and Oceanic Structure.** — (I. U. G. G.) According to R. M. Field, President, and J. A. Fleming, Secretary.

VII. **International Astronomical Union.** — According to A. Eddington, President; W. S. Adams, Secretary; and J. Stebbins, Chairman, American Section, I. A. U. Also, Committee on Distribution Astronomical Literature, A. A. U., B. J. Bok, Chairman.

VIII. **International Congress of Psychology.** — (Psychology has no international union). According to H. S. Langfeld, Secrétaire Adjoint.

IX. **Eighth American Scientific Congress** (1939). (21 American Republics). — Review as of 1944. According to A. Wetmore, Secretary; and W. Kelchner, Chief, Division of International Conferences, U. S. Department of State, and:

A. **Section on Physical and Chemical Sciences.** — According to L. J. Briggs, Chairman. (Restricted.)

B. **Section on Geological Sciences.** — According to T. W. Vaughan, Chairman.

C. **Section on Public Health and Medicine.** — According to T. Parran, Chairman.

D. **Section on International Scientific Exchange.** — C. H. Haring, Chairman.

E. **Section on Economics and Sociology.** — H. G. Moulton, Chairman.

F. **Section on Agriculture and Conservation.** — H. H. Bennett, Chairman.

G. **Section on Biological Sciences.** — E. G. Conklin, Chairman.

H. **Section on History and Geography.** — According to P. E. James, Chairman.

I. **Section on Anthropological Sciences.** — According to H. J. Spinden, Chairman.

J. **Section on International Law and Jurisprudence.** — G. A. Finch, Secretary.

K. **Section on Education.** — According to N. M. Butler, Chairman.

X. **International Scientific Organizations.** — According to W. G. Leland, Chairman, Advisory Committee on Cultural Relations, U. S. Department of State.

XI. **International Conferences on Intellectual Coöperation.** — Havana (1941). — A. Raestad and A. V. Hill, Secretary, Royal Society of London.

XII. **International Publications.** — By F. Verdoorn, Hon. Secretary, Botanical Section of the International Union of the Biological Sciences.

Part III

DIGEST OF THE REPLIES TO THE QUESTIONNAIRE

The following digest is intended as factual, rather than interpretative. For reasons stated on p. 255, the social sciences, as such, are not here explored. Since we are dealing with the written opinions of scientists on science rather than merely the descriptions of scientific apparatus and techniques, we may not all agree as to what is factual. This digest is, therefore, set up for future criticism by direct comparison with the documented data. It should be added that certain data have not been included in this Memorandum not because they are inconsequential, but because they are perhaps too personal, or too confidential for this Memorandum until they have been reconsidered by the reporters themselves in terms of this essentially comparative analysis.

To begin with, we may divide the digest into the following subdivisions:

A. *The extra-terrestrial sciences,* such as astronomy and cosmogony. An important connecting terrestrial link of astronomy may be found in the study of cosmic terrestrial relationships, especially of the earth, sun, and moon; also a branch of geophysics.

B. *The terrestrial or geosciences.* Composed of the decidedly overlapping departments of biology, geography, geology, and geophysics, together with their almost innumerable subdivisions and their consequent applications.

C. *The primary sciences.* Mathematics, chemistry and physics, or physical chemistry, and their many subdivisions and applications, including geochemistry and geophysics, which also overlap A and B.

This particular arbitrary classification of the sciences is in terms of the interrelations of the different recognized departments of science and of the professional classifications of the scientists.

A. **International Astronomical Union.** — Astronomy is not represented as such by a division of the National Research Council of the United States.

I. There has been considerable correspondence, during the war, between the executive officers of the Union. Because of continuing activities both Great Britain and the United States have adhered to the Union by paying their subscriptions. Previous to 1929 forty nations adhered to the Union.

II. The next international meeting of the Union will be held at the earliest opportunity. The last meeting (1941) was scheduled for Zurich, Switzerland. It has been suggested by the Bureau that the first post-war meeting might be held in the United States.

III. No interim reports during the war. The Union has no international journal.

IV. Some contacts with officers of other Unions, particularly Geodesy and Geophysics, but largely for business reasons.

V. Of the large number of international projects several have been kept going by payment of grants through neutral countries.

VI. Astronomers, as a whole, approve of the Union and consider it a most effective organization for active coöperation of the world's astronomers. The Royal Astronomical Society recently passed a resolution urging continuance of I. A. U.

"The new Chairman of the American Section of the I. A. U. is HARLOW SHAPLEY who, as President of the American Astronomical Society, will also act as Chairman of the Section when it becomes active again." (J. STEBBINS, Aug. 16, 1944.)

B. Geoscience.

a. **International Union of Biological Sciences (including Botanical Section).** — Biology is represented on the U. S. National Research Council by the Division of Biology and Agriculture.

I. With the exception of Latin America, there has been little contact between the officers of the Union since most of them are in Axis occupied territory and in Switzerland.

II. It is planned to hold a meeting of the Union in Sweden as soon as possible at the time of the 7th International Botanical Congress. The principal efforts at international intercommunication during the war are in the Botanical Section, whose Secretary is a Netherlands' expatriate now residing in the United States and close to the President of the Union.

III. Some commissions are still active but rather through individual than coöperative efforts.

IV. There are many projects requiring international coöperation.

V. The Botanical Secretary is now compiling a list of all international plant science organizations (ca. 70) and expects to report their current activities and post-war plans in the course of 1946.

VI. No comments as to desirability of post-war continuation of the Union as a whole, except for statement under II.

b. **Proposed American Horticultural Union.** — Of significance to this Memorandum because of its recognition of the international interrelation of science, education, arts, professions, humanities, amateurs (non-professionals) and business. Also of significance in any consideration of the post-war modification, or reorganization of the National Research Council of the United States.

I. There exists no International Horticultural Union. Following the 11th International Horticultural Congress held in Rome in 1935, there was discussed desirability of founding an International Horticultural Bureau. Later, while this discussion was still in progress, it was announced that the International Institute at Rome had decided to add to its organization a "horticultural section" to take the place of the projected bureau. Apparently nothing was actually accomplished in this direction prior to the opening of World War II (see *Chronica Botanica,* Volume IV, 1938, pp. 197-204). Consequently, the only international exchange of horticultural information (as mentioned above) has been either (*1*) between the U. S. Department of Agriculture and corresponding governmental agencies of other countries; (*2*) between various organizations, such as horticultural societies, garden clubs, special flower societies, trade groups, etc.; (*3*) between scientific institutions, such as botanical gardens, arboreta, colleges, experiment stations, etc.; or (*4*) between individuals and individual horticultural establishments such as nurseries, seed firms, etc. In no case could such interchange be considered "official" in the sense that it has been conducted by any group or agency delegated and authorized to represent and speak for all horticultural interests of the United States. Even at the various International Horticultural Congresses held from time to time prior to 1938, the United States was represented only by a member or members of the United States Department of Agriculture, appearing, of course, only on behalf of that agency.

II. For many years there have been frequent recurrences of a conviction on the part of different individuals that (*1*) the United States should have one overall group, council or other organization that could effectively represent all the interests and activities embraced in the field of horticulture; (*2*) *such an organization could and*

should be part of an international body through which horticultural knowledge could be exchanged between the countries of the world, with a view to making its benefits available to all mankind.

Within the past year this conviction, and its informal discussion, has resulted in the proposal that there be formed an American Horticultural Union, patterned in some respects after the existing unions of various scientific interests. This proposal is based on the following beliefs: (*1*) That horticulture which has been defined by Dr. L. H. Bailey as "the growing of flowers, fruits and vegetables and of plants for ornament and fancy" has not been as generally or fully appreciated as have the other closely related phases of the broad inclusive field of agriculture. (*2*) That the fundamental significance and potential benefit of horticulture to mankind as a constructive force in the promotion of national and international well-being have not been realized and are not being fully developed. (*3*) That there is a close and mutually advantageous relation between horticulture and the other arts and sciences that also has not been fully realized or utilized as a basic factor in the attainment of human welfare and social progress. ("Primarily, horticulture is an art, but it is intimately connected with science at every point." — L. H. Bailey) (*4*) That there exists in America at this time an exceptional opportunity to initiate and foster such recognition, appreciation and promotion. The United States, with its broadly representative range of terrain, climate and other factors that influence and govern plant growth, provides an illustration or demonstration of the principles of horticulture, greater than that offered by any other continuous land area in the world, with the possible exception of post-war Russia. Furthermore, American horticulture and horticulturists, because of their exceedingly favored situation, have before them an enviable opportunity and a definite responsibility to contribute in generous measure to the resources and leadership needed for a successful renewal of attempts to promote closer, more effective international relations in this field.

III. To date, the discussion of this proposal has focused upon the formation of a Horticultural Union which would include *membership sections* for the following classes of horticultural interests: (*1*) Scientific and Educational; (*2*) Professional, including the various arts and humanities concerned; (*3*) Amateur; (*4*) Commercial; and would include among its *objectives*: (*1*) The stimulation and promotion of horticultural research and teaching; (*2*) the fostering of a better understanding between them and all related fields of interests; (*3*) the inspiration and development in the public mind of a recognition of the importance of horticulture in its relation to the well being, culture and happiness of all people; (*4*) the adequate representation of horticulture both in American affairs and in international relations. To realize the last mentioned objective (*4*), such a Union is organized; to become affiliated with the existing International Union of Biological Sciences through the latter's American section; and, ultimately, through its own section for science and education, to coöperate, or become affiliated, with the National Research Council.

IV. It is the profound conviction of those interested in the formation of an American Horticultural Union (and, they hope, the formation in due course, of a corresponding international organization) that there are *many* projects — of scientific, social and popular character — which could be carried forward jointly by horticultural unions in the various countries with mutual benefit to the participating countries and their peoples, and, indeed, to the benefit of the world in general. Much thought is being given to the post-war problem of the building of a more stable world structure. It seems fitting, therefore, to consider the claims and potentialities of horticulture as a common denominator of human interests of many types, applicable in virtually all parts of the world, and practiced to some degree by all elements of society; as a subject whose enthusiasts include amateurs, professionals, commercial workers and scientists; as (to quote again Dr. L. H. Bailey) "a composite of botanical and agricultural subjects" and "a means of expressing the art sense"; as a range of human activities that reaches above, and is free from and untrammelled by the prejudices, complications and entanglements of political and economic relations. Such consideration is directly in line with the first duty of the National Research Council as set forth in President Wilson's Executive order of May 11, 1918: *viz.*, "In general, to stimulate research in the . . . sciences

and the application of these sciences to engineering, agriculture, medicine and other useful arts with the object of increasing knowledge, of strengthening the national defense, and of contributing in other ways to the public welfare."

c. 1. **International Paleontological Union.** — Of particular significance because of its interrelation with several other Unions and Congresses.

I. The principal intercommunications have been between the United States and the British Commonwealth, but there has been some communication with China and Australia and attempts are now being made to open communications with some of the continental European countries.

II. The Union plans to meet with the International Geological Congress when and where it decides to meet. Interrelated projects are: *1.* Measurement of geologic time. *2.* Nomenclature of stratigraphic units. An obvious interrelation when the International Union of Biological Sciences in Rules of Zoological Nomenclature.

III. Some of the committees are active, but the war has prevented others from functioning.

IV. Keeping in touch with the British officers of the next International Geological Congress.

V. The Paleontological Society (U. S. A.) is coöperating with the International Commission on Zoological Nomenclature, FRANCIS HEMMING (Great Britain), Secretary, to raise $9,000 as a revolving fund for its expenses. The Paleontological Society has published, in the January issue of the *Journal of Paleontology,* an appeal for donations from its members; and has followed that with another appeal, which was distributed with the bill for membership dues for 1945. To date members have contributed over $200. The Council of the Society is also applying to the Geological Society of America for a grant of $1,000 from the Penrose Fund for this purpose. In this connection special mention should be made of Biological Abstracts, a truly international organization with headquarters in the United States.

VI. The Union is essential to the solution of many international paleontological problems.

c. 2. **International Paleobotany.** — There is no international organization, as such, of paleobotany.

"The closest tie of paleobotanists is with the International Botanical Congresses, usually held every five years. At the International Botanical Congress of 1930, paleobotanists, as an International group, participated in a symposium of Carboniferous plants. After the International Botanical Congress of 1935, paleobotanists, as an international group, met with other paleontologists at Heerlen, to constitute a 2nd Congress for the Advancement of Studies of Carboniferous Stratigraphy. The 1st Congress for the Advancement of Studies of Carboniferous Stratigraphy met in Heerlen in 1927, and was a joint congress of paleobotanists, paleozoologists, and stratigraphers from many parts of the world.

There was no real international symposium on paleobotany at the last two meetings of the International Geological Congress, though many internationally-minded paleobotanists attended. At the XVI International Geological Congress several European paleobotanists, accompanied by American colleagues, made excursions in the United States, in order to attempt closer paleobotanical correlation between the United States and Europe. Several American paleobotanists reciprocated in 1935 by visiting European localities in the company of European paleobotanists. The results mentioned have helped tremendously in the mutual understanding of paleobotanical problems across the Atlantic.

Future methods of handling international aspects of paleobotany. "We should continue, perhaps, as an organized 'section' or 'division' of paleobotany, as a close tie with the International Botanical Congresses. Paleobotanists are now formally organized as one of the four sections of the Botanical Society of America. We should also plan

some kind of formal or informal connection with each International Geological Congress. Perhaps this can come about after the war through the International Paleontological Union, where paleobotany is represented. Perhaps it can best be accomplished by symposia on international aspects of paleobotany. In any case paleobotanists should be afforded opportunities to make paleobotanical excursions with foreign colleagues as a prime means of harmonizing international aspects of mutual problems.

We should encourage a broad international point of view among American paleobotanists. How? By exchange of graduate and post-graduate students between all possible countries. By publicizing (in Journals or National Research Council Reports on Paleobotany) outstanding paleobotanical publications of foreign colleagues. By admonishing American paleobotanists to attend and contribute to International Congresses, both Botanical and Geological. By individual attention to the exchange of separates with foreign colleagues. By further attention to foreign bibliographies and abstracting journals." (E. Dorf, Chairman, Committee on Paleobotany, N. R. C. (U. S. A.), Sept. 12, 1944.)

c. 3. **International Vertebrate Paleontology.** — "The status of the discipline of vertebrate paleontology in international coöperation is significant in scientific liaison in that it elucidates the origin and distribution of human racial groups and thus approaches social anthropology through biological and geological channels. There are no established ways, on the international level, of judging the calibre of scientific talent in this subject nor are there traditional means of selecting the most promising researches, regardless of locale, for coordinated effort. Therefore the progress that has occurred in these lines has been the result of individual initiative supported by institutional prerogative. A recently established organization, the Society of Vertebrate Paleontology, may be able to evaluate ability and to predict the value of potential research, by group encouragement, but it can only make recommendations. A means of integrating the various international motives and opportunities for advancing the discipline would extend and conjoin biology, geology, and social anthropology. We need this means." (G. L. Jepsen, Feb. 22, 1945.)

d. **International Medicine.** — "There are numerous international medical organizations — international congresses (*e.g.*, for mental hygiene, pediatrics, neurology, physiology, gastro-enterology), international associations (*e.g.*, related to psycho-analysis, urology, leprosy, microbiology), and international leagues and unions (*e.g.*, against venereal disease, rheumatism, epilepsy, tuberculosis, cancer). In the past the meetings of these organizations have been well attended and their value in promoting extensive acquaintance and in stimulating professional interests has been commonly recognized. During the war the organizations have not held meetings, because of the disruption of free movement among the nations and also because in all belligerent countries members of the medical profession have been too deeply involved in caring for the victims of warfare to be able to attend to other than their immediate professional duties. It is fair to state, however, that the medical profession occupies a uniquely favorable position for renewal of coöperative enterprises after the war ends. Traditionally, army physicians and army surgeons are not regarded as belligerents by either side engaged in the conflict. They serve the wounded, their own nationals and their foes alike. The community of aim of all doctors of medicine, wherever they may be and whatever their training — the mitigation of

human distress and the prevention of disease and premature death — unites them in a fraternity which disregards differences of race and nation. Disease does not respect artificial boundaries. And the spread of infection may be world wide, as was true of influenza in 1918. It seems probable that the establishment of collaborative enterprises after the war will be easier for international medical organizations than for many other groups engaged in scientific or technical activities." (W. B. CANNON, Sept. 8, 1944.)

e. **International Congress of Psychology.** — Psychology is represented on the United States National Research Council by the Division of Anthropology and Psychology.

I. No international exchange of information, other than for war purposes during the last two years.

II. Last congress was to have been held at Edinburg. The Assoc. Secretary (American) now in correspondence with the British as to time and place of next congress.

III. Inactive during war, due to impossibility of correspondence with majority of committee.

IV. *See* II.

V. Numerous projects in social psychology and anthropology require international coöperative research.

VI. Congress has been successful, but should be supplemented by coöperation between national associations of the various countries (such as is accomplished by an International Union). British psychologists "are of the opinion that we should hold the next Congress as soon as possible after the war."

f. **Archaeology.** — Apparently has no international Congress or Union, but included in this Memorandum because of its international importance as an agent in the comity of nations. Requires complete coöperation of specialists in Geology, Geophysics, Anthropology, Geography, Chemistry, and Biology.

At the request of the Division of Foreign Relations, N. R. C., Dr. C. R. MOREY has prepared the following statement relative to the national and international organization of archaeology: "National or international organizations of archaeology are the worst organized of any so far as I can see. We have a half dozen national societies that are interested in archaeology and the history of art with no system of coöperation, and so far as international unions or congresses on the general subject of archaeology are concerned, nothing of the sort exists. The need of such international coöperation has been obvious for some time. For example, an international union or a periodic international congress could do something about alleviating the strict law of export of antiquities that now inhibit the progress of excavating in Italy, Greece and some places in the Near East. Another advantage of such an international union or congress would be the detection and tracing of forgeries. Still another would be the bringing together of the various disciplines that can be listed under the head of archaeology and correcting the discrepancies in research that now result from too much departmentalization. One instance of the last named trouble is the fact that the theory of the evolution of Mediaeval Art in the United States is in many important respects quite divergent from that in Europe owing to the lack of exchange of ideas and publication." (Dec. 1, 1944.)

g. **International Geographical Union.** — Geography is represented on the U. S. National Research Council by the Division of Geology and Geography.

I. There has been no interchange of information between officers of the Union, including British and American, during last two years. One result has been a lapse of payments by both British and American Governments.

II. No plans for next meeting of the Union.
III. No activities since the war.
IV. Officers of the Union have not kept in touch with the officers and personnel of other Unions.
V. The chief scientific project in which the Union could participate is to stimulate production of the Carte du Monde au Millionième.
VI. The only real advantage of the Union seems to be the monetary assistance provided by the adhering governments. Suggested that the geographers revert to old system under which the principal geographical societies arranged between themselves for international gatherings and coöperation generally.

h. **International Geological Congress.** — Geology is represented on the National Research Council by the Division of Geology and Geography.

I. The XVIIIth Congress was to have been held in London, July, 1940. A balance of funds is now in custody of Geological Society of London pending any decision as to time and place of the next meeting.
II. Officers of the Congress are not particularly in touch with each other except through the Geological Society of London, and the Commission on Continental and Oceanic Structure, I. U. G. G.
II. The General Secretary reports "nothing doing at present."
IV. Officers of the Congress are not in touch with other Unions except through the "Commission" of the I. U. G. G.
V. There are no projects requiring international coöperation, as stated by General Secretary. See also statement by "Commission", I. U. G. G. (p. 276j).
VI. *See* I.

i. **Society of Economic Geologists.** — At the request of the Division of Foreign Relations, N. R. C., the Chairman of the Division of Geology and Geography, N. R. C., W. W. RUBEY, inquired of all "American" geological organizations as to their international affiliations and activities. The reply of Dr. C. H. BEHRE, JR., is here quoted in full.

"In contrast with the other strictly geological societies with headquarters in the United States, the Society of Economic Geologists has at least undertaken to be essentially *international* rather than *national* in membership, and to some though lesser degree in administration. This is indicated by its name, which does not include the term American; by its seal, which shows both hemispheres; and by its By-Laws which expressly state:

Article 2. . . . the Society's *international* character and scope . . . .
Article 4. . . . The regional officers shall consist of six *Regional* Vice-Presidents, *one from each of the continents* . . . .

Of the total membership of 464 as of 1943, 293 were from the Continental United States and four from the Philippine Islands. The rest, almost exactly 36 percent of the regular membership, were from "foreign" countries. Yet there is no specific ratio of American to "foreign" membership. The headquarters, however, and the majority of the officers are American.

I. 1. At least 5 of our 6 Regional Vice-Presidents are necessarily not residents in the United States or its territories. In the average year 1 of the 9 Councilors is from Canada and the President or Vice-President may be a Canadian. In its twenty-two administrations, the Society has had two major officers from Europe — a President from Germany and a First Vice-President from Sweden. — 2. There have been no communications with other national societies of other countries in any official manner.—3. Ditto, with respect to the national educational and research organizations of other countries. — 4. There is considerable personal correspondence between this office and other members of the Society situated in this country, on the one hand, and "foreign" members of our Society, on the other. Such correspondence deals with publications,

membership matters, research undertakings here or abroad, advice to "foreign" or American students, and procurement of publications.

II. Our Society has not contemplated an international meeting "as soon as world conditions permit", as distinct from its usual meetings. I should remark further that, as our meetings have invariably been in the United States (with the exception of one or two meetings and one or two field excursions in Canada) the international character of our meetings is not as successfully maintained as is desirable, in my opinion. This generally "American" tone at our meetings results, I believe, from the fact that the main administration and the larger proportion of the members are in this country. However, it would seem difficult for our relatively small and impecunious society to organize meetings elsewhere than in the United States or perhaps in Canada, though such meetings would certainly be possible undertakings. I believe that the membership would generally be of the opinion that the International Geological Congress (held, as you know, every third or fourth year in successively differing countries) and the various meetings of national geological and mining societies outside the United States afford adequate opportunities for international association without the large labor and expense involved in an additional international organization representing our Society.

III. 1. We issue no interim reports. However, we still publish regular, essentially monthly reports in our journal ("Economic Geology") and transmit these to all of our members to the extent to which government can permit international communication during the war. This practice has never been discontinued. In fact, it has, if anything, been appreciably *increased* since the beginning of the present war, and the most complete issue of our triennial "Proceedings" was published in 1943 and distributed to all our members, abroad and here, who could be reached by mail. — 2. Our international journal and transactions have been published throughout the war, much as usual. — 3. Government financing is not involved in our work. — 4. It is assumed that our relation with all foreign countries, including Axis-occupied countries, will be resumed after the war until it at least equals that prevailing before 1939. Even at present articles are submitted by non-American writers and are published on the same basis as those submitted by American writers. So far there has been no indication that any distinction in our attitude will be made after the war between the treatment of citizens of Axis-occupied countries or Axis countries on the one hand and those of friendly nations or of the United States on the other.

IV. The officers of our Society have not specifically kept in touch with the officers and personnel of other societies in the sense in which I read this question. In view of their accessibility and their similar problems, close coöperation exists, of course, between our Society and the other geological societies of the United States (especially the American Association of Petroleum Geologists, the Geological Society of America, the American Institute of Mining and Metallurgical Engineers, and to a lesser degree the American Geophysical Union. Moreover, several of our non-American members are also members of foreign geological societies and thus serve to link us with similar organizations elsewhere.

V. It is not an official opinion, but solely my personal impression that our Society could serve as a strong force in the following projects that are of great international importance to scientists in the fields represented by our Society:

A. New geologic mapping, and especially the assembling of what is already known about the geology of "backward" regions where geologic surveys do not function in their own right. This applies to much of Africa, much of South and Central America, much of eastern and southeastern Asia, and even to part of Mexico.

By systematic effort such work could be especially advanced by our Society because of our relative preponderance of mining geologists and (to a lesser degree) petroleum geologists, members of the Society, who are called to work in such little known areas.

B. The entire field of geochemistry as applied to deposition of ores and other useful mineral products could be coordinated and furthered by our Society.

C. Much basic work in applied ground-water geology and engineering geology. This could be stimulated by our Society and effectively distributed by publication in "Economic Geology".

D. The "Annotated Bibliography of Economic Geology", which undertakes to cover articles published in all languages and all countries, dealing with the subject of economic geology in its broadest sense, could well be made more effective as to coverage if the aid of non-American bibliographers could be enlisted in its compilation.

I am particularly glad that this question was asked, as it seems to me that our Society has failed to live up to its possibilities in the respects enumerated above. Probably other members of our Society could suggest at least an equal number of forms of international coöperation in scientific research.

VI. In my opinion (rather than in my experience, for my experience in international coöperation is very limited), the most effective plan for post-war efforts of the sort referred to would be for international unions or congresses to serve as coordinating agencies, operating largely through local societies. I am not certain that our own Society could go very far in initiating or furthering coöperation on an international scale of the type mentioned because of the limited funds available to it. It could suggest them and initiate them. More strictly national societies could carry them out within each country. The International Geological Congress, if *active,* could stimulate and correlate such work. In the past we have not shown great interest in this problem; perhaps in the future we may do so!" (Feb. 12, 1945.) *See also* American Association of Petroleum Geologists (B. ii).

ii. **The American Association of Petroleum Geologists.** — The reply of I. H. Cram, President (1945) is also quoted in full.

"The Association (and its 25 affiliated geological and geophysical organizations is the largest geological organization in the world, and although most of the members reside in the United States, the *membership is in fact international.* As the search for oil becomes more worldwide, more Association members will work in foreign countries. In the field of petroleum geology there is no rival organization. Recently the executive committee has taken steps to acquire and publish in the *Bulletin* and in special volumes more information on the petroleum geology of the world outside of the United States. Practically all of this material will be contributed by members. As we publish more foreign information, more foreign geologists will be attracted to membership in the Association. It is therefore my view that we as an Association are accomplishing at least in part the international coöperation desired." (I. H. Cram, Feb. 15, 1944.)

The Association has approximately 340 foreign members from 41 different countries, distributed as follows:

Angola	1	Dominican Republic	4	Nicaragua	2
Argentina	19	Ecuador	15	Palestine	2
Australia	9	Egypt	3	Persian Gulf	3
Barbados	1	England	14	Peru	5
Belgian Congo	1	Germany	1	Portugal	1
Bolivia	1	Haiti	2	Scotland	2
Brazil	2	India	2	Sumatra	2
British Guiana	1	Iran	1	Switzerland	9
Canada	58	Iraq	1	Syria	1
Chile	6	Japan	1	Trinidad	20
China	1	Java	1	Turkey	1
Colombia	45	Mexico	16	Uruguay	1
Costa Rica	1	Netherlands	1	Venezuela	70
Cuba	8	New Zealand	5		

j. **International Union of Geodesy and Geophysics.** — Geodesy and geophysics are represented on the U. S. National Research Council by the Executive Committee of the American Geophysical Union. The

Executive Committee of the A. G. U. also includes the chairmen of the Divisions of Foreign Relations, Physical Sciences, Chemistry and Chemical Technology, Geology and Geography, and Biology and Agriculture.

I. Officers and personnel of the Union have interchanged information with foreign countries, other than for war purposes during the past two years, especially with Great Britain and Canada.

II. The last international meeting was to have been held in Norway. According to a letter from the Norwegian Embassy, Washington, D. C.: "The Ministry of Education and Ecclesiastical Affairs considers the invitation to be still in force and regards it as a great honor for Norway to be host for the next meeting of your Union, in which so many Norwegian Scientists have taken an active part." (Nov. 23, 1943.)

III. Informal interim reports are maintained through national committees. *See also* Central International Commission. The Union has maintained contacts with the other Unions, notably the I. A. U., and the I. C. S. U., during the war period. Triennial and other publications will be resumed after the war, and copies of the 1939 Transactions are reserved for distribution to all adhering nations at the earliest opportunity. The Union continues to receive dues, because of adherence, from the United States Government, and from the British Government. The bulk of the Union's funds are banked in Great Britain and in the United States. The Union, during the war, has financed several projects.

IV. *See* reports from the Associations and Commissions (pp. 272-277).

V. A large number of projects in which the Union coöperates and should continue to coöperate, with equal advantage to all countries.

VI. Post-war international coöperation in science and education could not be better served by other organizations than by international scientific unions. Of the 32 countries which adhere to this Union, 3 are 'Axis' enemies, 14 are in enemy hands, 4 are neutrals with whom no contact is allowed, 4 are British, and 7 are in the Americas. The particular value of a union, rather than a congress, is that a union provides: 1, Continuity of touch in administration and finance. 2, Power of instituting, at once, some much needed practical collaboration, with a minimum of institutional or national politics. (March, 1944.)

a. International Association of Geodesy: —

I. Frequent contact has been maintained by correspondence between American officers of the International Association of Geodesy with accessible officers of that organization and of the International Union of Geodesy and Geophysics in other countries. The national society (or nearest corresponding organization) for Geodesy in the United States of America is the Section of Geodesy of the American Geophysical Union. There has been contact by correspondence between its officers and members and geodesists in other countries. Some of the work done by the U. S. Coast and Geodetic Survey is restricted or confidential during the war. No other information available. Considerable attention has been given to promoting an interest in geodesy and to the initiation of actual geodetic work in Latin America. Some of the Latin American countries have been nominal members of the International Union of Geodesy and Geophysics and therefore of the International Association of Geodesy but have taken almost no part in its affairs. It is hoped that after the war all Latin American countries will participate actively in the work of the International Association of Geodesy.

II. It is planned to hold a meeting of the International Union of Geodesy and Geophysics, and of its branch, the International Association of Geodesy, at Bergen, Norway, as soon as conditions will permit. The invitation for the Bergen meeting was given and accepted at the 1939 meeting in Washington, D. C.

III. War conditions prevented the publication of much of the material that would normally have been published in connection with the 1939 meeting of the International Association of Geodesy. The publication of two reports of the International Association of Geodesy, which would otherwise have gone unpublished, was undertaken by the U. S. Coast and Geodetic Survey. The American Geophysical Union sponsored

and financed the publication of a pamphlet containing the proceedings of the 1939 (Washington) meeting of the International Association of Geodesy. These proceedings would normally have been published in the *Bulletin geodésique,* official organ of the International Association of Geodesy, publication of which was interrupted by the war. The correspondence already referred to dealt in part with the resumption of publication of various sorts. The International Union of Geodesy and Geophysics of which the International Association of Geodesy is a branch, has continued to receive from the State Department money for the annual dues of the United States of America to the International Union of Geodesy and Geophysics.

IV. Contact particularly with the International Astronomical Union, especially in connection with the work of the International Latitude Service, which receives support both from the International Astronomical Union and the International Association of Geodesy (compare this statement with that of the I. A. U.).

V. In geodesy alone there are the International Latitude Service (Central Office at Naples), the Bureau international de l'Heure (Central Office in Paris) and the Isostatic Reduction Office (office in Helsinki). "The International Bibliography of Geodesy is issued triennially, but only two volumes have appeared and not enough copies are available. This Bibliography covers in principle all European languages and includes non-critical abstracts of the books and articles listed. This Bibliography of Geodesy is extremely useful and deserves international support, because the income received from subscribers and purchasers of copies will not suffice to maintain it." (W. D. LAMBERT, Sept. 7, 1944.) Some means should be found to assure the continuance of these offices.

The International Association of Geodesy also has triennial reports made by designated reporters on various branches of the subject. These should be of general interest to member countries, though not necessarily, of course, equally so to all of them.

VI. Something very like the Unions is needed in my opinion. Congresses do not ensure the necessary continuity nor provide for the support of continuing projects, such as are mentioned under V. Congresses do, however, make possible a wider participation by interested persons. There is always the possibility that the Unions, with their attendance limited to official delegates, may get into the hands of a self-perpetuating clique.

Perhaps the Unions might sponsor Congresses with fewer restrictions on the attendance of delegates, or provision might be made for larger and possibly more representative delegations to the ordinary Union meetings. These meetings, however, could easily become too large for the convenient transaction of necessary business, in which case such business would probably be railroaded through by a small cohesive group.

There seems to be no ideal solution. (Sept. 4, 1944.)

b. International Association of Seismology: —

I. Considerable correspondence has been carried on with available officers of both the Association and the Union during the war. Appointment of a Vice-President to replace the deceased (French). Contact maintained with national societies and their international operations. Personal correspondence and informal conferences regarding post-war plans. "Dr. ROBERT STONELY of Cambridge University (England) has accepted appointment as acting vice-president of the Association to replace F. J. WHIPPLE (deceased). On the assumption that central France may soon be liberated I have informed acting Vice-President STONELY of my views as to what ought to be done about the Central Bureau of the International Association of Seismology." (N. H. HECK, President, Aug. 12, 1944.)

II. *See* j. V and VI (p. 276).

III. Interim reports have been made, particularly to the N. R. C. and to allied American organizations, including government agencies. Together with Commission on Continental and Oceanic Structure the Association has helped finance continuity of seismograph stations in Greenland and Bermuda.

IV. It has kept in touch with all available officers, or their alternates, of the other International Associations.

V. Seismology is essentially an international subject which requires complete interchange of instrumental records and the careful consideration of the best location of seismographs in all parts of the world.

VI. Since the Association survived the last war, and has shown considerable vitality during this one, its continuance is particularly warranted.

c. International Association of Meteorology: —

I. No direct interchange of information has gone on during the war through officers of this Association except between England and the U. S. A. Science abstracts have been helpful. Also wireless abstracts and occasional scientific reprints are received from colleagues in Sweden and Switzerland. There has been no direct scientific contact with Russia.

II. Preparations should be started for an international meeting of the Executive Committees of the Union and their associations, with, possibly, addition of other scientists personally invited.

III. The Royal Society is considering the whole future of international organizations of science, with special committees considering future needs of the various branches of geophysics, including a review of governmental help, regarded as necessary.

IV. *See* I.

V. There are a number of international projects in which the Association should participate, to a much larger extent than before the war.

VI. Renewal and improvement of the Union and its associations are most important for the progress of science, especially astronomy and geophysics. Activities can be most usefully extended, but methods to be adopted will need careful consideration to avoid some of the jealousies (*see* pp. 285-287) and inefficiency in the pre-war unions.

d. International Association of Magnetism and Electricity: —

I. Informal interim reports have been continued since 1929 through several committees and commissions. Continuance of magnetic character-figures has been maintained with the coöperation of the Carnegie Institution of Washington.

II. *See* I.

III. *See* I.

IV. Important fundamental problems, the solution of which requires the continuous international coöperation of geomagnetism, meteorology and volcanism, are being carefully considered.

V. A number of specific projects require the help of the other associations, because of essential international continuity of instrumental surveys and interchange of observations and record, such as: maintenance of magnetic character of days, reduction of magnetic observations of isomagnetic charts, etc. *See also* report of Commission on Continental and Oceanic Structure (p. 276).

VI. The Association, because of its contacts, experience and interests, is particularly prepared for coöperation with other international agencies in post-war science and education. This is particularly true in the case of oceanographic magnetic surveys, both for fundamental and practical reasons.

e. International Association of Oceanography. — For sub-oceanic geomorphology and geology *see* report of Commission on Contintental and Oceanic Structure, I. U. G. G.

I. No comments.

II. The National Committee appreciates the economic and political aspects of scientific oceanography.

III. No comments.

IV. The National Committee is particularly interested in planning a vigorous program of research in the Pacific Ocean, and will need the coöperation of the Association.

f. **International Association of Vulcanology.** — No report has been received, but a statement by its Vice-President (U. S. A.), August 8, 1943, is as follows: "I do not believe in international organizations but in individuals . . . Vulcanological research should be entirely local and institutional." *See also* statement of the Commission on Continental and Oceanic Structure (p. 276). In contradistinction it is reported from London that "as no communication has been, or is, possible between the President of the Association, Professor Michel-Levy, and the world outside the conflict, the Secretary-General, Brigadier Winterbotham, has appointed J. E. Richey as an Emergency President to act for Professor Michel-Levy."

g. **International Association of Hydrology:** —

I. Since 1939 there has been limited correspondence among the officers of the Association.

II. The work of the Association has been done chiefly through the agency of several International Commissions, the principal ones being: Commissions on Potamology, Limnology, Subterranean Water, Snow and Glaciers. All of these commissions have European Presidents except the Commission on Snow and Glaciers and the Commission on Subterranean Water. *See* separate report by J. E. Church, President, Commission on Snow and Glaciers and O. E. Meinzer, President, Commission on Subterranean Water (pp. 275, 276).

III. The Vice-President of the Association was present at the last meeting of the I. U. G. G. in Washington, 1939. The Secretary of the Association arrived but left immediately on account of the war. F. E. Matthes served as temporary Chairman for the Washington meeting, but the Proceedings have not yet been published.

IV. *See* I and II.

V. *See* reports of Commissions on Subterranean Water and on Snow and Glaciers.

VI. "The next meeting of the International Association of Scientific Hydrology will, of course, be determined by the decisions that are made in regard to the next meeting of the International Union of Geodesy and Geophysics, of which it is a part. It seems to me that it is too early to make decisions in regard to such a meeting, but I am heartily in favor of holding a meeting as soon after the war as may be practicable. It would certainly be fine if the meeting could be held in Norway, as was voted at the Washington meeting (1939), but I appreciate that our plans will have to be adapted to the conditions that will exist at the close of the war." (O. E. Meinzer, Aug. 26, 1944.)

h. **International Commission on Snow and Glaciers:** —

I. There has been some correspondence, since 1939, with Russia, Switzerland, England, Australia, New Zealand.

II. The plan is to meet with the International Union of Geodesy and Geophysics at Oslo or Bergen, Norway, to catch up on the program for 1942, wrecked by the war.

III. As a result of the war, substitute officers were temporarily selected, for those in occupied countries, to carry on the business of the Association, in order to restart full international activity at the very first possible moment.

1. No interim reports.
2. Resumption of an international journal or transactions.
3. Reprints have been stored for distribution to all countries as soon as possible.

IV. There has been interchange of opinions, particularly during the war, with Gerald Seligman, England, and Otto Lütschg, President of the Association, Switzerland.

V. Numerous projects require international coöperation for the benefit of all countries. We are, therefore, not waiting for the war to end in order "to reawaken scientifically to the melancholy waste of time in destroying what has been so laboriously built up." (J. E. Church, Aug. 28, 1944.)

VI. *See* II. Also: "The Association of Scientific Hydrology deserves specific commendation because of the breadth of view and sturdy leadership of its past president, SMETNA, and President LÜTSCHG. Its executive Committee even on the eve of the outbreak of hostilities was represented in a meeting of the countries of Europe and showed a remarkable unanimity of policy and loyal support of President LÜTSCHG as against the ultra conservative attitude of our French Secretary, DIENERT." (J. E. CHURCH, Aug. 28, 1944.)

i. International Commission on Subterranean Water:—

I. There has been correspondence with the President and Vice-President of the International Association of Scientific Hydrology; also with the President of the International Commission on Snow and Glaciers. There has also been some correspondence with members of the Commission, in different parts of the world, during the war. The principal activity of the Commission, during the war, has been in the Western Hemisphere with the members and advisory members from the Latin American countries. This activity has been aided by the coöperation of the U. S. Geological Survey, the Pan-American Union, and the Office of the Coordinator of Inter-American affairs. This has been accomplished in spite of the pressure of war work. (*See* Transactions of the American Geophysical Union for 1943 and 1944.)

II. *See* p. 275, g. II.

III. *See* I.

IV. Only through the central bureau of the International Association of Scientific Hydrology, *see* I.

V. Not mentioned specifically, but implied.

VI. Not mentioned specifically, but implied.

j. International Commission on Continental and Oceanic Structure.—This central organization was created by the International Union of Geodesy and Geophysics during the Seventh General Assembly at Edinburgh in 1936. Its primary function is to promote the use of geophysical methods in the solution of the structural problems of suboceanic and continental areas, with the essential coöperation of geologists and their national and international organizations.

I. There has been interchange of information with all available officers of the I. U. G. G., both in the U. S. A., and other countries during the war; also with such national societies as the American Institute of Mining Engineers, the American Association of Petroleum Geologists, the American Physics Society, the American Institute of Physics, the Geological Society of America, the Geological Society of London, and numerous educational and research institutions.

II. A report is planned for the next meeting of the International Union of Geodesy and Geophysics.

III. The Commission has contributed to several interim reports (1939-1944), including those of the Division of Foreign Relations, N. R. C. Its last interim report was published in April, 1943, and it has material already prepared for the resumption of the transactions of the I. U. G. G. The work of the Commission is still maintained by funds from the I. U. G. G.

IV. The Commission has maintained continuous communication with the American (U. S. A., Canada, and Mexico) officers of the I. U. G. G., also with the officers of the International Geological Congress, and the American representatives of related international organizations, *i.e.*, physics, engineering, chemistry, meteorology, geophysics, and, when necessary, with the U. S. Department of State, and the Washington Embassies of the Netherlands, Norway, and Finland.

V. International projects which have been sponsored by the Commission are: (*1*) Gravimetric and suboceanic topographic surveys of the Gulf Caribbean region and the English Channel, requiring the coöperation of the International Association of Geodesy, the British and American Navies, the United States Coast and Geodetic Sur-

vey, the American Bell Telephone Laboratories, the Royal Society of Great Britain, Cambridge University (England), Lehigh University (U. S. A.), Princeton University (U. S. A.), the U. S. National Research Council, the American Geophysical Union, and other private national institutions and agencies. (*2*) Initiated suboceanic seismic exploration of the Atlantic Ocean with the coöperation of the International Association of Terrestrial Magnetism and Electricity, the United States Geological Survey, the Geological Society of America, the Woods Hole Oceanographic Institute (U. S. A.), the U. S. National Research Council, the Guggenheim Foundation (U. S. A.), the Geological Society of London, the Royal Society of London, and other private national institutions and business corporations. (*3*) Coöperation with the International Association of Seismology in the maintenance of seismographic stations in Bermuda, Greenland, and Latin American Countries. (*4*) Coöperation in the tabulation and publication of international data of international significance.

VI. The Commission has particularly stressed the need for further coöperation of numerous agencies in the solution of fundamental problems in geoscience, both within and without the I. U. G. G. Examples: (*1*) Geographic coordinates in relation to problems in structural geology. (*2*) Plans for joint British-American survey of the Mid-Atlantic Ridge. (*3*) Continuation of geophysical-geological exploration of island arcs, as essential to better understanding of mountain building and geosynclines. (*4*) Study of earthquake velocities and isoporic foci with special reference to differences in the continental and suboceanic lithosphere. (*5*) The geophysical, as well as the geochemical, study of volcanoes as an indication of subcrustal conditions. (*6*) Configuration of the Pre-Cambrian basement. (*7*) Cosmic terrestrial relationships. (*8*) Contributions to the methods for improving international coöperation in science and its social implications.

VII. In spite of the war the Commission has been able to prepare for its post-war responsibilities by maintaining correspondence, and informal conferences, with the available officers of the Associations of the I. U. G. G., including its General Secretary. It has further maintained its interim efficiency by the appointment of alternates for 'Axis', and for 'Axis' occupied countries, until such time as the scientists of these countries are able to resume their proper responsibilities. As an active implement of the I. U. G. G., the Commission considers that all international scientific unions have exceptional opportunities for the increase of comity among nations through international coöperation in fundamental science.

C. **The Primary Sciences** (as defined on p. 263.)

a. **International Union of Pure and Applied Physics.** — Physics is represented on the U. S. National Research Council by the Division of Physical Sciences. No report (*See* Part V, p. 290.)

I. *International Bureau of Weights and Measures.* The office of the Bureau is located in Paris. A recent letter from the Director made no mention of interference with his work other than that he found it necessary to make a great reduction in his staff owing to lack of funds. The U. S. Government and that of Great Britain has a definite policy not to transmit funds to agencies in occupied (and Russia occupied?) territory.

2. *International Commission on Illumination.* Represented on the U. S. National Research Council. It is reported inactive during the past year, but the National Committee of the I. C. I. met in November, 1933, and elected officers.

3. *International Electrotechnical Commissions.* Represented on the U. S. National Research Council. It is reported inactive during the past year, but the National Committee of the I. C. C. held its annual meeting and elected officers in December, 1943.

4. *International Scientific Radio Union.* Represented on the U. S. National Research Council. Reported no activity during the past four years.

b. **International Union of Chemistry.** — Chemistry is represented

on the U. S. National Research Council by the Division of Chemistry and Chemical Technology: —

I. The Union has maintained contact with the National Committees and Societies of Sweden, Switzerland, Russia, Spain, England, and Mexico, as well as with individuals and organizations in Peru, Chile, Argentina, China, and Australia.

II. At the last meeting of the Union (1938) it was planned to hold the next meeting in London in conjunction with a Congress of Applied Chemistry.

III. A valuable feature of the Union is the ability to help organize national committees in various fields, especially nomenclature and standards. Such committees of the Union are still at work. Examples: Committee on Atoms, Annual Tables of Physical Constants, Committee on Revision of Biological Chemistry, Committee on Carbohydrate Nomenclature, etc.

IV. *See* I.

V. *See* III.

VI. Not specifically answered, but implied.

c. **International Mathematics.** — Mathematics is not represented on the National Research Council by a Division, except as it is covered by the Division of Physical Sciences. The following report comes from the former Secretary of the International Mathematical Congress.

I. Individuals have kept up desultory correspondence with research mathematicians in all countries except Germany and some of the occupied countries (and in some cases clandestine correspondence with the exceptioned countries). Relations with Britain during the last two years in regard to war research have been intimate. "More than half of the leading 300 American mathematicians are engaged full-time in the mathematics underlying the mechanical engineering of war weapons. There are today more of the leading German mathematicians in the United States than there are in Germany." The method of correspondence with Russia has been to write to the Academy and request that the attention of certain people be called to the questions raised. This method has been successful, and is all the more important because "quite extraordinary mathematical developments are taking place in Russia and the feeling between Russian mathematicians and the American mathematicians, which has always been cordial, continues to be so."

II. The Congress which was to have been held in Cambridge, Mass. (Harvard University?), under the auspices of the American Mathematical Society in September, 1940, was postponed. It is expected that as soon as travel conditions warrant after cessation of hostilities this Congress will be held. "American mathematicians believe that they can contribute to the peace of the world by keeping up cordial relations with colleagues in all countries (including many who are anti-Nazi or non-political in Germany)."

III. Several libraries and individuals have been able to obtain practically all the mathematical material published in Europe. During the war period journals from Germany and Russia are somewhat belated in reaching the United States, but are obtained by some of the libraries which are making the contents available on microfilm to interested parties.

IV. *See* I.

V. In 1938, the Germans disrupted the staff of the *Zentralblatt für Mathematik und ihre Grenzgebiete*. The United States then started its own abstracting Journal, *Mathematical Reviews*, edited by OTTO NEUGEBAUER, formerly of the *Zentralblatt*.

VI. "For over fifty years the mathematicians have been holding International Congresses, generally at four-year intervals. It has been found that these congresses are better handled without the aid of the organization of an international union. Mathematics does not require such intimate international coöperation as projects in Astronomy." (R. G. D. RICHARDSON, Aug. 22, 1944.)

D. **VIIIth International Science Congress (1939).** — This is a type illustration of an international meeting instigated by one or more govern-

ments and including all phases of science, history, politics, economics, and education. The following report is as of 1944. W. Kelchner, Chief, Division of International Conferences, U. S. Department of State, has been very helpful in advising on all matters relating to international conferences. He has not, however, expressed his opinion for this report as to the efficiency of the congress: —

a. *Section on Physical and Chemical Sciences.*

I. The Congress did not particularly further stimulate international correspondence in chemistry and physics.

II. No further meeting is planned.

III. There has been limited correspondence with government officials and other individuals in Mexico and in South America.

IV. *See* III.

V. Not answered; but it is noted that there are very few contributions on physics and chemistry from Latin America.

VI. Except for the United States and Canada, there is not enough Pan-American interest to warrant another meeting.

b. *Section on Geological Sciences.*

I. The only continuing activity is the promotion of a geological map of South America similar to the geological map of Canada and the United States.

II. The Geological Section was disbanded at close of the sessions.

III. *See* I.

IV. Not officially.

V. *See* I.

VI. Next Congress planned to meet in Cuba when conditions permit.

c. *Section on Public Health and Medicine.* No comment except that the Congress has not yet attained the status of a permanent body.

d. *Section on International Scientific Exchange.*

I. The Section has had no relations with organizations or individuals since 1940.

II. Not planning to meet again.

III. "Section not a congress, a society, a union, a council, or anything else deserving recognition by the Division of Foreign Relations, N. R. C."

IV. *See* I.

V. *See* I.

VI. *See* II.

e. *Section on Economics and Sociology.*

I. The Section has not functioned since the meeting of the Congress. There has been no personal correspondence except to obtain manuscripts for publication in the proceedings.

II. Not answered except by implication.

III. *See* I.

IV. *See* I.

V. *See* I.

VI. Not answered.

f. *Section on Agriculture and Conservation.*

I. Apparently the Section of Agriculture and Conservation of the Eighth American Scientific Congress has ceased functioning and, for all practical purposes, no longer exists. In the field of soil and water conservation, however, the Pan-American Soil Conservation Commission has been created in accordance with a Resolution passed at the meeting of the Eighth Scientific Congress, and this body has functioned as well as one might reasonably expect during the wartime period. There has been correspondence and some interchange of information between the officers and personnel of the Commission in the United States and foreign countries, and between the Commission and various appropriate scientific and educational societies.

II. The Commission is seriously considering an international meeting as soon as world conditions permit in order to provide for an orderly exchange of information and to help provide sound scientific guidance to the healthy interest in soil and water

conservation work which is developing with truly astonishing speed in many countries of the world, and particularly in the Americas. This matter may be further discussed by members of the Commission at a meeting of the Third Inter-American conference to be held at Caracas, Venezuela, July, 1945.

III. From available information, the Commission has not maintained or undertaken to date the activities listed in this category, although the Commission contemplates the preparation of interim reports, the preparation of an international journal, and the international interchange of technical bulletins and other information on soil and water conservation as soon as world conditions permit. Nothing definite, however, has as yet been determined with regard to these activities.

IV. A number of the Commission's officers have kept in touch, on an informal basis, with their colleagues in the other Unions, and particularly with the Pan-American Union.

V. The Pan-American Soil Conservation Commission could participate, with essentially equal advantage to all coöperating countries, in a variety of scientific projects in the field of soil and water conservation. There is already considerable enthusiasm in several countries (as expressed, also, at the United Nations Conference on Food and Agriculture) for the inauguration of such projects.

VI. While much good toward post-war international coöperation could be achieved through activities of international scientific congresses and unions I still think we also need a wide exchange of students who would carry out some actual work to show what nations can do to help one another. In the field of agriculture the Soil Conservation Mission to Venezuela after making recommendations with respect to a practical work program for that country went into the field and actually carried out on a variety of farms soil conservation operations as we perform them in the United States. This proved helpful and Venezuela is continuing the work that our mission got under way. Another instance is that of Dr. W. C. LOWDERMILK of this service who on his visit to China, 1943, carried out actual soil conservation work with a large number of Chinese technicians. I think this kind of practical coöperation would accomplish a great deal in the way of better international understanding in furtherance of accomplishments of international scientific congresses." H. H. BENNETT, Feb. 22, 1945. Mention should also be made of the International Society of Soil Science which operates continuously (since 1926) by means of six commissions and several subcommissions. (L. L. LEE, March, 1945.)

g. *Section on Biological Sciences.* No reply due to illness of Chairman.

h. *Section on History and Geography.*

I. There has been no interchange of information since the meeting of the Congress, but some personal correspondence with Latin Americans.

II. It is supposed that the Section will meet again, but the Congresses are planned by the State Department and the officers do not continue from year to year (between meetings?).

III. The Congress is not a continuing affair.

IV. *See* III.

V. Special international projects do not apply to a scientific Congress.

VI. *See* II.

i. *Section on International Law and Jurisprudence.* This Section was created only to function during the Congress (May 10-18, 1940), and the activities of the officers of the Section were entirely concerned with preparations for the meeting and with preparation and editing of the proceedings.

j. *Section on Anthropological Sciences.*

I. Duties of Section were limited to inviting Latin American and United States workers in these fields to attend the Congress and present papers, to the arrangement of a program and to some advice on the publication of results. The work of the Section terminated with the publication of Vol. II of the Proceedings in 1942.

II. It is hoped that there will be post-war international coöperation in science, education, and other cultural activities and that they will derive their powers from genuinely democratic institutions free of all political dictation.

III, IV, V, VI. Referred to General Secretary of the Congress.

k. *Section on Education.* With the completing of the Congress there has been no further official activity of this Section, or of its members.

l. *Congress as a Whole.*

I. "It is my (A. WETMORE, Sec. Gen. of the Congress) own feeling that these congresses serve a very definite function here in the New World in promoting closer relations among scientific workers."

II. The expenses of these congresses are met by the host country. Each of these congresses operates independently of its predecessors since the officers for each congress are selected by the country that is host for the meeting. The next meeting is to be held in Cuba at a time to be designated by the authorities of that country. The officers of the 9th Congress also will be selected by the Cuban authorities.

III. Under the conditions (*see II*) interim reports are not made except in the form of the Proceedings which it has been customary to publish as soon after the Congress as practicable. For this Congress the Proceedings are 12 volumes—one volume on the Congress as a whole, with an additional volume for each of the 11 Sections.

IV. *See* VI.

V. Resolutions were adopted which have led to continued activities that are still being promoted. Specifically mentioned: The development of an international statistical organization to promote this type of work and the formation of an Inter-American Institute to deal with tropical agriculture, work under which is now going actively forward.

VI. "The result of this last Congress has been most gratifying in its development of closer relations between scientific workers in a wide variety of fields in all the 21 American Republics." (Compare with previous statements of Chairmen of Sections.)

E. **International Scientific Organizations: —**

"A problem of great importance that will shortly become one of extreme urgency has to do with the continuation and the resumption of activities of the numerous international scientific organizations that existed in 1939.

Such organizations have been created in almost all fields of science and scholarship. They include not only the international scientific unions, federated in the International Council of Scientific Unions, but also the International Union of Academies, the International Committee of Historical Sciences, the International Federation of Library Associations, the International Congress of Orientalists, the International Congress of Linguists, the International Congresses of Anthropology and Ethnology, etc. These organizations had developed into important agencies for promoting collaboration between the intellectuals of the different countries and for providing occasions for those intellectuals to meet at regular intervals.

After the end of hostilities, a situation analogous to that of 1919-1920 will exist, but it will be much more serious in degree. When the International Research Council was organized, German scientists were excluded from it and from the scientific unions for a period of years. When the International Union of Academies was organized in 1919 there was no exclusion of former enemy countries, but it was more than a decade before the German and Austrian academies became affiliated with the Union.

This situation gave rise to much uneasiness, and created difficulties with respect to the international congresses which are well remembered. Is it possible now to foresee the time when, and the circumstances under which, it will be possible to bring together German scholars and those of the other countries where a systematic effort has been made to destroy intellectual life into personal coöperation? Much will depend upon the degree of intellectual liberty which German scholars enjoy after the war, for the situation in the late '30's demonstrated convincingly how impossible it is for free scholars to work with those who are not free. Something also will depend upon the nature of the disciplines involved, for certain disciplines, such as anthropology, history, sociology, etc., are much more affected by emotional factors than are such disciplines as astronomy and geology.

It has been suggested that the practical course would be to resume as soon as possible activities of collaboration and publication that do not involve the actual meeting

of scholars and scientists, but that it will probably be inexpedient to attempt to hold international congresses until after a certain period has elapsed.

Another problem that American scientists and scholars must consider is what part the Government should be asked to take in the support of the international organizations. Up to the present time the Government has not supported them except to pay the dues of the United States in the international scientific unions, and to a minor extent through the purchase of publications. Now, however, that the Government has a working policy of cultural relations with other countries, and since the private funds from which most assistance to international activities has been drawn are greatly diminished, it is proper to inquire whether the Government should not assume a much larger part of the expense of American participation in international organizations. There are excellent arguments on both sides of this question, and I think it would be useful for the four national councils, as well as other interested national organizations, to give the matter immediate and careful attention." (W. G. LELAND, Report to Division of Foreign Relations, N. R. C., April, 1944.)

F. Excerpts from the International Conference on Intellectual Coöperation in Havana, November, 1941: —

"Any international organization desirous to spread information regarding the needs for the safeguarding of peace or on the work of the League of Nations or on the merits of the democratic way, risks having little success with a country's Press, Radio or Film, for the simple reason that, in general, the Directors of the institutions in question wish to obtain on such matters the contributions of nationals, who, themselves, form their conclusions. In each nation there is prevalent a prejudice against foreigners tendering advice in matters of high concern to the nation and a disinclination to admit that political ideas, which originated outside the country, can be acted upon in the country just as they are ready made. Incidentally, a proof that such is the tendency is provided by the fact that in no country do the great media of public opinion reproduce to any extent the result obtained by the political or legal sciences of other nations or pay any great attention to their economists or publicists.

"The situation is different when it comes to the exact sciences the propositions of which are proved or refuted from observations or experiences according to established rules. Science has progressed enormously in our time. All the same, the results and methods which constitute the achievements of science do not reach the public to a sufficient extent nor in a satisfactory way today, in spite of a glamour of our Press, our Radio and our recording industry. As reproduced by these media scientific discoveries often are distorted or travestied. On that point the conditions do not improve; on the contrary they get worse. The masses, while knowing that science is great, do not get half the knowledge they wish or that might be useful to them. To attain this purpose, we must have a new class of scientists, a class that does not exist today — that is to say, of intermediary scientists who, interpreting discoveries in physics or chemistry, are to convert a meaning originally expressed in a highly symbolized mathematical language into a literary form with scientific exactness, thus enabling the real vulgarizers — journalists, radio commentators, film-script authors, etc., to present the matter to a general public with the maximum degree of exactness. What we need is, in other words, a link which belongs to science, itself, between the original scientists exploring the universe and those final distributors of scientific results and methods, who, in order to appeal to the public, must possess literary style and qualities of taste and a certain pedagogical ability. That a better knowledge of the results and methods of science (a knowledge the public does not possess today and never has possessed) is apt to help mankind, we somehow take for granted even if we deem, with ROUSSEAU, that science in itself does not serve social progress. In order to solve this problem, what is needed is coöperation between the different centres of sciences and, more particularly, the academies of science and the associations for the advancement of Science. Such a coöperation was on its way in 1939.

"Assistance to already existing scientific organizations and enterprises and the starting of new ones. The Organization for Intellectual Coöperation of the League of Nations was active only during recent years. Owing to its connection with Govern-

ments, the 'Organization' was able to give practical effect to ideas which up till then had been desiderata only (unifying of methods used in archeological excavations, introduction of the Latin alphabet to new countries, etc.). The 'Organization' was also helpful in organizing scientific conferences (in problems of physics, meteorology, etc.) and initiated some new enterprises (dictionaries and catalogues). The 'Organization' assumed the functions of a secretariat to some scientific unions and enterprises, especially in the field of the exact sciences. In this latter field the work of the 'Organization' developed fast as was natural because of the fact that science has become more and more a collectively organized activity which ignores national frontiers. Under the impact of the progressive specializing of the sciences, more and more international unions are created, and more and more international enterprises are started. In some cases, however, the union or the enterprise lacks the necessary means to enlist help; in other cases being a private organization, it has no such ready access to governments as might be desirable. In the field of the exact sciences, in 1937, the Council of Scientific Unions was formed, and for this council, the 'Organization' has acted as secretariat, without thereby endorsing the principal idea which underlay the formation of the Council, namely *that the men of the exact sciences should take a more active part in social politics.*" (A. Raestad, Nov. 1941.)

In May, 1942, A. Raestad received the following letter from A. V. Hill:

"I am very much obliged to you for your letter of 27 April and for your interesting report of the conference in which you participated last November. As you know, international coöperation in the scientific field is a matter which I have very closely at heart, and during the war itself I have been very concerned to see that proper scientific collaboration is established between the allies who are fighting together against a system which would mean the end of scientific freedom. To take an example only, the Royal Society of which I am secretary, saw an opportunity recently in the presence in London of a number of scientific representatives of the Dominions to collect them together to discuss coöperation, particularly with a view to the future, in scientific work. We have held a number of meetings and hope that in the end important results may be achieved. Later on, when we are clearer as to our plans, we hope to get America's representatives also to join us, and one of the things which we intend then to consider is the reestablishment of the international scientific unions which existed up to the time when the war began.

"In all such ways I believe that scientific people can help in the reestablishment of sensible friendly arrangements between different nations, and one may hope that those who are concerned with other studies, disciplines and branches of learning may find the same opportunities of collaboration as we in the natural sciences.

"The important thing in all this, I think, is to collaborate, *for by the actual process of collaboration we learn to understand each other and to find how it should be done. Solvitur ambulando.*

"All good wishes to you therefore, in your endeavours."

G. International Directories: —

In reporting separately on the activities of the Botanical Section of the International Union of the Biological Sciences, Frans Verdoorn communicates as follows: "One of the most important and most pressing post-war duties of international organizations is to prepare new, up-to-date directories of research institutions and research workers. They are the basic tools in international relations work. In the case of such directories it is time to break with the old fashioned way of listing the scientist's activities in a vague, general way, *e.g., Plant physiology.* This is not too helpful from the point of view of international relations. It is much better to add a note about the work in which the colleague listed is currently engaged, *e.g., vernalization of cereals.*

Part IV

SUMMARY OF MAJORITY AND MINORITY OPINIONS

I. Participation of scientists and technological experts in organized international conferences may be classified as follows:

A. As expert advisers (consultants) to their respective governments, either as heads or delegates of government bureaux, or as individuals recommended or selected from the personnel of private organizations, such as universities and industrial corporations.

B. As members of bureaus or commissions organized by their respective governments, and largely, if not entirely, composed of government employees.

C. As representatives in congresses which are, or are not, preponderant in government personnel. It is peculiar to congresses that they have little or no continuity between meetings, which occur every three or four years.

D. As delegates of national academies, national societies and national research and educational institutions. Such international meetings are claimed to be less influenced by geopolitics, but they are the most sporadic, and depend entirely (to date) in most countries on private (philanthropic) financing. It is only in the case of classes A and B that the delegates are not expected to pay most, if not all, of their own expenses. It should be further noted that A and B illustrate the organization of scientists — partly, if not mainly — for economic and political (geopolitical) reasons, while C may be "border-line"; in this respect, D is primarily "international-academic". There appear to be certain practical differences between the Royal Society of Great Britain and the United States National Academy of Sciences. Sir HENRY T. TIZARD, Foreign Secretary of the Royal Society, states that the Royal Society has no scientific or political responsibility to the British Government, though the advice of the Society on scientific matters is often sought and on many occasions has been directly offered. The United States National Academy of Sciences was established precisely to bring to the aid of the Government the abilities and judgments of the leading men of science when that aid is asked. The National Research Council is an operating agency of the Academy, but, as such, was given the following directives by President WILSON in 1918:

"EXECUTIVE ORDER

The National Research Council was organized in 1916 at the request of the President by the National Academy of Sciences, under its congressional charter, as a measure of national preparedness. The work accomplished by the Council in organizing research and in securing coöperation of military and civilian agencies in the solution of military problems demonstrates its capacity for larger service. The National Academy of Sciences is therefore requested to perpetuate the National Research Council, the duties of which shall be as follows:

1. In general, to stimulate research in the mathematical, physical and biological sciences, and in the application of these sciences to engineering, agriculture, medicine and other useful arts, with the object of increasing knowledge, of strengthening the national defense, and of contributing in other ways to the public welfare.

2. To survey the larger possibilities of science, to formulate comprehensive projects of research, and to develop effective means of utilizing the scientific and technical resources of the country for dealing with these projects.

3. To promote coöperation in research, at home and abroad, in order to secure concentration of effort, minimize duplication, and stimulate progress; but in all coöperative undertakings to give encouragement to individual initiative, as fundamentally important to the advancement of science.

4. To serve as a means of bringing American and foreign investigators into active coöperation with the scientific and technical services to the War and Navy Departments and with those of the civil branches of the Government.

5. To direct the attention of scientific and technical investigators to the present importance of military and industrial problems in connection with the war, and to aid in the solution of these problems by organizing specific researches.

6. To gather and collate scientific and technical information, at home and abroad, in coöperation with governmental and other agencies, and to render such information available to duly accredited persons.

Effective prosecution of the Council's work requires the cordial collaboration of the scientific and technical branches of the Government, both military and civil. To this end representatives of the Government, upon the nomination of the National Academy of Sciences, will be designated by the President as members of the Council, as heretofore, and the heads of the departments immediately concerned will continue to coöperate in every way that may be required.

The White House (Signed) WOODROW WILSON
11 May, 1918 (No. 2859)"

The Russian Academy of Sciences is *directly* responsible to its Government. It should also be added that certain criticisms by American scientists of the lack of academic freedom of Russian scientists are incorrect, and largely founded upon the opinions expressed by some officers of some American scientific organizations. It is, perhaps, for this reason that recently the Russian Government, through its Academy, has preferred to communicate with individual American scientists rather than with their organizations.

E. As unions (international scientific unions). Here are combined many of the best (most constructive) features in A, B, C, and D, with important additional features such as: (*1*) Continuity of responsibilities, effort and finance, (*2*) a minimum of political and economic control by government agencies.

II. The following digest is primarily in terms of the opinions of scientists who have participated in one or more of the types of international conferences listed as A to E, and secondarily, according to their technical aptitudes. It should be noted, however, that with very few exceptions this is a digest of North American (United States, Canadian) and British Commonwealth opinions, *i.e.,* the opinions of the English-speaking scientists, and of their institutions. The reasons for the lack of available Latin American opinions are stated in Part III, D, pp. 278-283, together with the necessity for the opinions of other nations, notably the Netherlands, Switzerland, and the Finno-Scandinavian countries. Turkey and Russia exhibit a significant hiatus; and Germany, Italy, and France require immediate consideration in any post-war agenda and program on science and its social relations in Western Europe. The same is true for Japan and China in Asia.

III. *Digest.* The majority opinion of the available, responsible officers of international scientific organizations is that they are an essential implement to the progress and comity of nations. This is all the more significant because the roster includes scientists in the employ of both private and government organizations. But it should be noted that this majority opinion is largely due to geoscientists and to astronomers; an important exception are the geographers. In the case of mathematics it would appear that the leaders are somewhat asocial both in research and education, and have a tendency to national hibernation — in the scholarly sense — during periods of international conflict. This may be, in part, because research in fundamental mathematics is largely independent of travel and related observation even in times of world peace, when it is both helpful and pleasant to associate with — and honor — one's colleagues. There are some notable exceptions to this temporary analysis, but principally in the field of applied mathematics, as particularly exemplified by engineering, geophysics, and economics. Perhaps the mathematicians and astronomers best illustrate the aphorism of Dr. BRUZS of Latvia in his 1938 report to the Committee on Science and its Social Relations, of the International Council of Sci-

entific Unions: "I distinguish two elements in science, its utility and its intellectual charm."

Because chemistry and physics are fundamental techniques to all the other natural sciences they are, *par excellence,* examples of the interrelation of science and society through their economic application, particularly in medicine and in manufacture. It is therefore of some interest to note and compare the reports of American officers, and their adjutants, of the International organizations of chemistry and physics. According to the preceding introduction, the summary of the available data may be summarized as follows:

The majority opinion of the responding, responsible officers of the international scientific unions is:

1. *The scientific unions,* in view of their past experience, and accomplishments (1919-1944) are the most efficient existing international organizations both in promoting fundamental science, and in implementing the relation of science to human affairs. The principal defects in the past history of the unions which may be rectified by amendments to their charters are: (*a*) political jealousies arising from national pride, (*b*) over-emphasis of delegates of national institutions rather than of the science which the institutions represent, (*c*) national economic rivalry in the allocation of international funds and (*d*) indifference and consequent inefficiency of national committees. However, it has been demonstrated by those unions whose officers have accepted their responsibilities (1919-1944) that the self-criticisms listed have not seriously interfered with the fundamental directives or continuity of the unions; and, as well recognized, human phenomena are by no means peculiar to scientific organizations!

2. *International Congresses,* which have been primarily organized for national or geopolitical purposes, have been neither economical of the public funds, nor efficient in the expenditure of the scientists' time and energy. One reason why this has not been more fully appreciated by the public and their governmental representatives is not so much the technical difficulties of science as the fact that government scientists who participate in such congresses may not express their personal opinions on the efficiency of international meetings organized by their government. Furthermore, most non-government-employed scientists do not wish to discuss such matters as a scientific problem; those who do discuss them usually do so in relation to "academic freedom", "political control", "unscientific methods", and "emotionalism", which they attribute to either the legislative, or the executive (or both) branches of their government. This appears to be particularly the case in the United States, regardless of whether the critics are academicians or employed by commercial organizations. In the case of those Congresses which are primarily organized by the scientists themselves, the principal self-criticism seems to be lack of continuity in international coöperation between meetings. Many scientists, however, feel that this is a good thing because it prohibits the growth of purely political motives, while encouraging the further development of personal and group contacts as the desire for such coöperation develops naturally with the progress and consequent changes in scientific problems and techniques. Another difficulty is the lack of funds, except as raised by the national committee for the expenses of the congress in the country where it is held. This also is deemed an advantage by some scientists as it precludes any of the responsibilities connected with the administration of international funds.

3. *International Scientific Conferences Organized by National Private Organizations.* There is a strong preference among certain British and American scientists for this form of international coöperation, particularly in fundamental science. This preference, however, seems to be principally confined to college and university scientists, and especially those who have been elected to our most honored and most selective national academies and national societies. Other scientists, however, have noted that such international conferences are criticized by the public, and also tend to create political problems within the scientific body itself. Some of this criticism is probably

partly instigated through pique, but is certainly legitimate when it concerns science and society; also when it concerns inter-university and inter-academic rivalries rather than their coöperation. It seems, however, that there is a strong sentiment among some of the most able and most thoughtful scientists in the United States and the British Commonwealth favoring this method of international conferences, in spite of its lack of continuity and assured economy. The underlying implication, however, is the desire for conservative leadership and the complete avoidance of governmental control. For the reasons stated, it is particularly important that a careful, comparative analysis be made of the objectives and directives and organization of the Russian Academy of Sciences, The Royal Society of London, and the United States National Academy of Sciences. Probably no study by scientists of the impact of science on society could be more salutary for science and society. Such a study might serve to bridge certain troublesome difficulties which have arisen between the humanities and the sciences, particularly in the still largely theoretical fields of ideology and the "social sciences".

The answers to the questionnaire, plus additional correspondence, intimate, to date, that the most effective organized method of international coöperation in science is by means of the International Scientific Unions. This is, however, only a majority opinion — and also only a majority opinion of the available (Anglo-American) officers of the Unions.

To quote A. V. Hill, Secretary of The Royal Society of London: "The important thing in all this, I think, is to collaborate, for by the actual process of collaboration we learn to understand each other and to find out how it should be done. *Solvitur ambulando.*"

The international scientific unions have had more experience, both during war and peace, in all of the above mentioned problems in science and its social relations than any other type of international scientific organizations. The responsible officers of these unions are better aware, and consequently better prepared, to deal with these problems, and to improve their methods in dealing with them.

Part V

CONCLUSIONS AND RECOMMENDATIONS

"Only in their *natural settings* can we fully understand the languages, literatures, codes, ideas, interests and moralities of peoples unlike ourselves." ISAIAH BOWMAN, *New York Times,* Feb. 21, 1944.

"Molto bello, I agree with every word. Unfortunately, however, Italy has never been in a position where she could anticipate having access on equal terms to raw materials." MUSSOLINI to SUMNER WELLES, Feb. 25, 1940, quoted from *The Time for Decision,* Harper and Brothers, Publishers.

"It makes more than ever clear in my own mind the truth of what your President has said, that one of the essentials to a lasting peace is freedom and information." NEVILLE CHAMBERLAIN to SUMNER WELLES, March, 1940, *ibid.*

"Senators and Congressmen (legislators) are generally more responsive to opinions that come from voters in their own districts than to resolutions by a society with which they have no personal contact." Editorial. Mining and Metallurgical Society of America, *News Letter,* Nov. 15, 1943.

"There is an unfortunate tendency in easy times for the positions of responsibility to fall into the hands of men who are of the 'committee' or 'organization' type, for there are always available a number of men who like such assignments and perform adequately when not under pressure, but who may not have the energy and leadership to organize and direct a great program. This is particularly true when there is a tendency, quite naturally, to 'honor' a man because of his distinction rather than to select a man because he is the one on whom you would like to rely in a crisis like the present one." K. T. COMPTON to R. M. FIELD. Personal communication.

The "natural settings" within the national boundaries of any sovereign area include the discovery, exploration, and exploitation of all useful materials at, or near, the surface to a depth of one or more miles. The discovery, exploitation, and development of the useful materials depend primarily upon the scientific and technological ability of the inhabitants of the area. The scientific and technological ability of any nation depends, largely, upon its ability to exchange information with the technical experts of other nations. The useful materials are frequently referred to as "raw materials", or those materials without any, or all, of which a nation cannot manufacture the articles which it desires. All national and international trade in manufactured articles depends first of all upon access to "raw materials" and technology. Private enterprise has made great contributions to science and technology, but this is not recognized in the cost sheets of our national budget.

We have known for hundreds of years that the growth of science and technology has been most rapid in those countries which have had the most complete access to the required raw materials. The industrial progress of any nation depends, first of all, upon the interdependence of technology and

raw materials. With relatively recent acceleration in the growth of science and technology, industrial progress has required a greater quantity and variety of raw materials. Compare the amount and variety of raw materials needed by Great Britain when it had already created its Empire, with the amount and variety of raw materials which Great Britain now needs to even maintain a "Commonwealth of Nations." Compare Great Britain and Italy, from the same point of view, immediately after the signing of the Treaty of Versailles. This is an example of the relation of geoscience to geoeconomics and geopolitics. We continue to learn, through the acceleration in the growth of science and technology, that all nations are not equally favored in the quantity, quality, and variety of their raw materials; and that some nations have supplies of nearly all the raw materials they need, with surplus supplies of many commodities, while others are either deficient, or entirely lacking in certain of their requirements. According to boundaries, as of 1944, however, *no* single nation had assumed possession of, or access to, all of the raw materials vitally needed both in peace and war. Science, through synthesis (physical and organic chemistry and engineering, etc.) is learning how to help to alleviate some of the difficulties of this geoeconomic problem, but it cannot hope to solve the problem without also giving careful consideration to the excess raw materials within certain national areas. This knowledge is acquired through science and technology, and especially through the earth sciences, such as geology, geophysics, geochemistry, and biology.

The natural setting of any nation also includes the character and diversity of its topography, climate, and soils, with the consequent biology and ecology. It is this physical superficial variety in geography which must be still more fully understood in order to appreciate the origin of the more obvious differences in the "codes, ideas, interests, and moralities of people unlike ourselves." The basis of this knowledge also rests on science.

The future rôle of science will be increasingly social in that science and human affairs have become inseparable. Popular science may no longer be defined only in terms of the marvels of inventions and new gadgets; popular science must also include the relation of science to society, and the sincere attempt by scientists, to see that this information is available not only to a few favored individuals or groups, but to all elements of society through whose coöperative efforts their developed environments have been created.

The proper relation of science to government has been seriously neglected by our scientific leaders, and their organizations. Although readily available, there is little or no "freedom of information" even in the democracies, between our legislative and scientific organizations. This impractical situation is illustrated by many instances of well-meaning, but unnecessarily confusing and debatable legislative acts and proposals in the United States, such as Senate Bill S. 702, and its relation to the directives and responsibilities of the United States National Research Council and its parent organization, the National Academy of Sciences. Surely we need better liaison between science, public opinion and government than now exists through the separate deliberations of national scientific societies or academies, and of "Senators and Congressmen (who) are generally more responsive

to opinions that come from voters in their own districts". It is in the fields of medicine and engineering that scientists and technologists appear to have gained the most experience in improving the liaison between science and society, through economic necessity. It is suggested that this same necessity also exists in the whole complex area of science and international affairs, and that scientists have not yet thoroughly and scientifically considered this necessity as an ever increasing responsibility in the complete rôle of their activities. During the past two years we have had an excellent demonstration of the necessity of science in the art of geowar, and the remarkable recognition by scientists of this necessity. Will scientists equally recognize the necessity of their even greater responsibilities in helping to prepare for the period of reconstruction? The time is now, and it is still possible in the democracies for scientific men to select, for this purpose, those leaders whom they particularly trust in "an emergency".

Conclusions: — According to this Memorandum the international scientific organizations which seem to have operated most continuously and effectively from 1919 to 1944 are the International Unions of Astronomy, Chemistry, Geodesy and Geophysics, and Biology. The International Union of Pure and Applied Physics appears to have been the least active, and the least valued by its officers and members, either for the promotion of fundamental or applied physics. Due to the lack of expressed opinion (to date) on this matter by either the British or American officers of the Union, it is necessary to note the information provided by the Director of the recently formed American Institute of Physics, and by the President of the Massachusetts Institute of Technology.

"I have not, myself, been familiar with the activities of the International Union of Pure and Applied Physics . . . Until the Nazis began to close the laboratories of Germany it was the rule all over the world that physicists traveled freely. They could always enter a physics laboratory anywhere. They would be cordially received and shown all the researches in progress. The personal acquaintances across boundaries have always been close and numerous. I want to emphasize this because it has practically been very close to an ideal international coöperative arrangement and has been far more effective than any formal organization of unions or associations that has ever existed in science." (H. A. Barton, Aug. 21, 1944.)

"In so far as I can evaluate the matter, there has been no international organization of physicists which has been effective or significant. . . . Whether or not physicists have lost good opportunities through failure to develop a stronger interest in formal international organization is rather hard to evaluate. I have seen much of stimulus and value in a few of the international organizations in other fields such as the International Congress of Applied Mechanics. . . . I am inclined to think that the physicists generally look upon their scientific societies of physics as distinctly 'professional' and they prefer to let their participation in such more inclusive bodies as the Academy and Association of the American Institute of Physics be an expression of their active interest in such border questions as 'The Importance of Physics on Society' and so forth. . . . Finally I would say that I think an international union of physics could be successful if an enthusiastic group of young physicists in different countries were to approach the problem with necessary zeal. Otherwise, I do not think such a union would be successful or worth much time and effort." (K. T. Compton, Aug. 21, 1944.)

With the possible exception of the chemists, the primary scientists (as defined C, p. 263) suggests that they can accomplish more in the promotion of their technical interests without the organization of an international union.

It is further implied that they prefer to consider the impact of their technology on society within their national societies, and national academies. It would seem, therefore, that these national societies, national institutes, and national academies have a special responsibility in the problems of science and its social relations, particularly in relation to mathematics and physics.

One of the most active international scientific unions — with also particularly active national committees—is that of Geodesy and Geophysics. It is in this field of the application of physics to the study of the composition and structure of the earth that physicists seem to be more familiar with, and more interested in, the borderlines of science and human relations. The geophysicists also seem to be impelled by the same urge for continuous organized international coöperation as the astronomers, because of their mutual need of continuous, world-wide, field-observation as well as the interchange of the latest laboratory techniques and apparatus.

Geographers seem to be less definitive in their statements on international organizations. Further data are needed, but the American geographers, at present, do not seem to feel the need of either the present international union, or even an international congress. The geologists have no union, but have held successful congresses — the last in Russia. At present some of the leading American geologists are concerned with the organization of an American Geological Institute, patterned particularly on the American Institute of Physics and supported by national, founder, geological and geophysical organizations, but without international contacts.

In the United States it appears that the physicists, geologists, and geographers (both fundamental and applied) are favoring separate, technical national organizations in the approach to international problems. The recent statement (*Scientific Monthly,* August, 1944, p. 95) by Isaiah Bowman, President of Johns Hopkins University, and one of America's most eminent geographers, is pertinent to the international aspects of the close relation of history, science, and the humanities in research and in education. "We should make a Ph.D. mean something more than proficiency in a small sector of a great subject. A man should be capable of thinking about the meaning and the applications of his science, and not merely about a job in teaching 'courses' or advancement in salary in an industry by knowing enough to hold his job."

It would seem that the fields of anthropology and archeology have not been sufficiently explored from the international point of view, especially by the International Council of Scientific Unions and its Committee on Science and its Social Relations. Any nation may be proud of its archeology without interfering with the same pride in any other nation. Anthropology may be a somewhat delicate matter from the purely racial and national point of view; however, the natural self-interest of a group of people in themselves is best promoted by their personal participation in the required coöperative research. . . . "in our recent study of the Navajo Indian Problem I doubted if anywhere else in the world we could find a parallel to the extent of scientific research conducted as a basis for the reconstruction and human betterment program." (C. T. Loram to R. G. Harrison, 1940.) The success of this method is especially well illustrated by H. S. Colton and his staff, of the Museum of Arizona at Flagstaff.

In Western Europe in the Mediterranean area, in the Far East, and in Mexico, archeologists have already demonstrated both the right and wrong methods in international scientific coöperative research. The same is true in South America. Because of recent developments of essential techniques, from such diverse subjects as aerial photography to stratigraphy, the opportunities for interscientific and international coöperative research, from the geoscientific point of view, offer great possibilities.

Of all the natural sciences, probably biology — particularly botany — has the most promising future opportunity for promoting the welfare and comity of nations. "The natural sciences are a particularly fruitful field for international collaboration because they are themselves international; basic physical and biological laws are the same everywhere and are universally accepted. There is already a good deal of collaboration but much more could be done. Joint planning and exchange of information, services, materials, and personnel could and should be carried out in such a way that nations would be encouraged and assisted in enlarging agricultural research, applicable to their problems, while costly duplication could be reduced . . . ." (From: Final Act and Section Reports, United Nations Conference on Food and Agriculture, Hot Springs, Va., May 18-June 3, 1943, p. 54.)

Of particular significance is the growing appreciation by horticulturists of the intimate relation of plants to both the physical and cultural needs of all nations and races. Closely related to victory gardens, garden clubs, and landscape architecture, is the increasing popular interest and appreciation of the preservation of wild life in such sanctuaries as national reservations and national parks. Probably in no border-line of natural science is the amateur taking a greater and healthier interest in the relation of technology, economics, and politics to human affairs than in horticulture.

The problem of languages and international inter-communication has been as much, or more, discussed by scientists than by humanitarians. Only the mathematicians and the chemists have developed a fully accepted symbolism or "shorthand" which is truly international. The biologists and paleontologists of all countries continue to use Latin and Greek as basis for their classifications of animals and plants. These forms of international language, however, are effective only among scientists themselves and hinder rather than promote popular science both nationally and internationally. *No characteristic of a race, or of a nation, is so thoroughly a human characteristic as language.* Too great insistence at international meetings by the French that theirs be the "Court Language" has aroused serious international jealousies. Also because of their wide colonization and consequent technical and economic advantages, the English speaking scientists have expected "foreign" scientists to speak English. This disadvantage to the art of international inter-communications has been enhanced by the educational policies of both American and British Universities — particularly in their graduate schools — with the consequent decrease of the natural collaboration of the sciences and the humanities. The recent experiments in Esperanto and Basic English, or any other international language, illustrate mechanical methods for dealing with a fundamentally non-mechanical problem. The recent experiments by the Army and Navy schools, in teaching our soldiers and sailors the rudiments of such languages as Japanese, Chi-

nese, and Polynesian dialects, should be carefully considered by American schools and colleges.

The resumption of international scientific coöperation in fundamental science, as well as in science and its social relations, depends primarily upon the reservoir of scientific personnel in the about-to-be liberated countries, especially the smaller countries whose scientists have contributed so much to the progress of science and philosophy. American and British organizations — both universities and industrial corporations — have rendered a great service to the salvage of European scientists during the war. How many of these expatriate scientists will be ready and willing to return to their own countries and take active part in their reconstruction? In the United States there is already some evidence that these expatriates are planning not to return to their native lands. Entirely aside from the temporary technical advantage to this country, the concentration of the best European technical brains in North America and Britain will still further impoverish those already ravaged civilizations whose reconstruction depends fully as much on technical as on political leadership.

Finally, there is a serious need for an international scientific periodical devoted to the subject of science and its social relations. The English scientific periodical, *Nature,* and the official publications of the American Association for the Advancement of Science, *Science* and *The Scientific Monthly,* have recently helped to restore the philosophical and humanitarian aspects of science, so seriously neglected by educational institutions during the past fifty or more years.

Recommendations: — It has been definitely stated by the Allied Governments that post-war planning must be carried on during the winning of the war. The British, Russian, American, and Chinese Governments are already engaged in attempts at solving political, economic, and educational problems of the post-war period. On the assumption that science and technology are fundamental techniques in international relations, and that fundamental science affords an excellent opportunity for the improvement of methods in the art of international collaboration, the following suggestions are submitted as part of this Memorandum:

1. The Foreign Secretaries of the Russian Academy of Science, The Royal Society of Great Britain, and the National Academy of Sciences of the United States should explore the possibilities of an inter-Academy study of their international relations in those phases of science which are of benefit to all men and inimical to none.
2. The International Council of Scientific Unions, through its British and American officers, should simultaneously prepare a memorandum for all governments which have adhered to the International Scientific Unions, on how the Unions may best collaborate in post-war research and educational problems.
3. The Division of Foreign Relations of the United States National Research Council should continue to advise the United States Academy of Sciences in all international scientific matters which may, or may not, be in the self-interest of United States scientists, their institutions, and their related responsibilities, to the welfare of their countrymen.

Walter B. Cannon
Chairman, Division of Foreign Relations, N.R.C.; Foreign Secretary, National Academy of Sciences

Richard M. Field
American Representative, Committee on Science and its Social Relations, I. C. S. U.; Member, Division of Foreign Relations, N. R. C.

Appendix 1

A LIST OF THOSE WHO HAVE CONTRIBUTED TO THE PREPARATION OF THIS MEMORANDUM

W. S. Adams (astronomy)*
H. R. Aldrich (geology)
T. B. Appleget (science and society)
C. F. Arden-Close (geography)*
L. H. Bailey (horticulture)
H. A. Barton (physics)
C. H. Behre (economic geology)
H. H. Bennett (soil conservation)*
C. H. Birdseye, deceased May 30, 1941 (geography)*
M. T. Bogert (chemistry)*
B. J. Bok (astronomy)
I. Bowman (geography)
L. J. Briggs (physics)*
E. Bruce (geology)
E. C. Brunauer (international conferences)
D. Brunt (meteorology)
Dr. Bruzs (C. S. S. R.; I. C. S. U.)
V. Bush (O. S. R. D.)
N. M. Butler (education)*
W. B. Cannon (medicine and education)*
S. Chapman (meteorology and magnetism)*
J. E. Church (hydrology)*
B. Colby (economics and sociology)*
H. S. Colton (archeology)
K. T. Compton (physics and engineering)
E. G. Conklin (biology)*
I. H. Cram (geology)
E. C. Crittenden (physics and engineering)
J. H. Dellinger (physics)*
W. M. de Morgenstierne (international conferences)
E. Dorf (paleobotany)
S. Duggan (education)
A. Eddington (astronomy)*
L. P. Eisenhart (mathematics and physics)*
R. M. Field (geophysics, geology and social relations)*
G. A. Finch (international law)
J. A. Fleming (geophysics — magnetism)*
D. Friedman (international conferences)
A. Gregg (medicine and education)

---

* Names marked with an asterisk are executive officers, or adjutants, of an international scientific organization.

H. E. GREGORY (geology)*
F. B. HANSON (education)
C. H. HARING (international scientific exchange)*
R. G. HARRISON (biology)
N. H. HECK (geophysics — geomagnetism and seismology)*
A. V. HILL (medicine and education)
B. F. HOWELL (paleontology)*
J. A. JAGGAR (volcanism)*
P. E. JAMES (geography)*
H. JEFFREYS (mathematics and geophysics)*
G. L. JEPSEN (vertebrate paleontology)
L. JORSTED (international conferences)
W. KELCHNER (international conferences)
W. H. KENERSON (international conferences)
A. KNOPF (geology)
W. D. LAMBERT (geodesy)*
H. S. LANGFELD (psychology)*
L. L. LEE (soil conservation)
W. G. LELAND (education)
A. I. LEVORSEN (geology)
C. T. LORAM (education-science and social relations)
O. LÜTSCHG (hydrology)*
J. B. MACELWANE (seismology)*
F. E. MATTHES (hydrology)*
W. MAUK (education)
W. F. T. MCLINTOCK (geography)*
O. E. MEINZER (hydrology)*
E. D. MERRILL (biology)*
S. T. MILLS (education)
C. R. MOREY (archeology)
H. G. MOULTON (economics and sociology)*
D. G. MUNRO (education)
J. NEEDHAM (international conferences and biochemistry)
N. J. OGILVIE (geophysics and geodesy)*
J. H. OORT (astronomy)*
T. PARRAN (medicine)*
W. R. PECK (education)
H. J. PROCOPE (international conferences)
R. PYLE (horticulture)
A. RAESTAD (astronomy and international conferences)*
R. G. D. RICHARDSON (mathematics and engineering)*
J. E. RICHEY (volcanology)*
N. A. ROCKEFELLER (education and international conferences)
C. ROGERS (education)
J. E. R. ROSS (statistician-education)
M. ROSS (education)
J. B. SCOTT, deceased June 25, 1943 (international law)*
E. L. D. SEYMOUR (horticulture)
H. SHAPLEY (education and astronomy)
M. SIEGBAHN (physics)*
E. W. SKEATS (geology and geophysics)
R. C. SMITH (Latin American countries)
H. J. SPINDEN (anthropology)*
J. STEBBINS (astronomy)
H. T. STETSON (cosmic terrestrial relations)
J. Q. STEWART (astronomy)
F. M. J. STRATTON (science and social relations)*
L. B. STRAUB (O. S. R. D.)

W. T. THOM (geology, geophysics, and social relations)
T. G. THOMPSON (oceanography)*
R. ULICH (international education)
W. VAN BOETZELAER (international conferences)
H. VAN VREDENBURCH (international conferences)
T. W. VAUGHN (oceanography)*
F. VERDOORN (botany)*
W. VOGT (education)
SUMNER WELLES (international relations)
A. WETMORE (international conferences)*
P. C. WHITNEY (international conferences)
C. L. WILLARD (international conferences)
WENDELL WILLKIE, deceased Oct. 8, 1944 (interational relations)
H. ST. J. L. WINTERBOTHAM (geophysics)*
J. K. WRIGHT (geography)*

Appendix 2

JOSEPH NEEDHAM'S "THE PLACE OF SCIENCE AND INTERNATIONAL SCIENTIFIC COÖPERATION IN POST-WAR WORLD COÖPERATION

On April 28, 1945, Dr. JOSEPH NEEDHAM issued, from Chungking, the final, third edition of his memorandum on "The Place of Science and International Scientific Coöperation in Post-War World Organization". NEEDHAM's memorandum, because it argues for the inclusion of science in the United Nations Organization (U.N.O.) should be compared and contrasted with the mimeographed bulletin "The Proposed Educational and Cultural Organizations of the United Nations", recently issued by the Division of Public Liaison, (U.S.) Department of State (September 1, 1945), with the attached statement that: "This material will be available shortly in pamphlet form, upon request addressed to this Division". NEEDHAM is to be congratulated on the care, time and thought which he has devoted to the compilation of his memoranda. Whether or not we agree with his latest conclusions or advice we should be grateful to him for the most complete summary of the problem which has, to date, been made available by any scientist or scientific organization of the British Commonwealth. Its chief value — we feel — is due to the facts: 1) it is full of personal contacts with many responsible workers in the U.S.A. and abroad, 2) his observations are carefully contrasted, without personal and institutional prejudice and with considerable insight as to the divergence of opinions of those in authority both in the United States and in the British Commonwealth. On September 12, 1945, the senior author of this booklet summarized his opinion as follows: "NEEDHAM's memorandum III certainly presents an elaborate—indeed, a grandiose plan. It would require immense sums to put it into operation . . . I also explained again [to the Foreign Secretary of the Royal Society] why we based our hopes of international coöperation in science on existing international unions". It is significant that NEEDHAM has dropped all refer-

ence to the directives and responsibilities of the International Council of Scientific Unions (I.C.S.U.) in his Memorandum III. He argues for the necessity of an International Science Coöperative Service (I.S.C.S.), and the importance of changing the name and organization of the United Nations Education and Cultural Organization (U.N.E.C.O.) so that it shall become the U.N.E.S.(Science)C.O. On September 11, 1945, V. CONNELL, Esq., of the United Kingdom Scientific Mission in the U.S.A., wrote us as follows: "Dr. NEEDHAM's memorandum is not an official statement but expresses his views. The question of science and post-war planning is receiving a good deal of attention in official circles in Great Britain at the present time and Dr. NEEDHAM's memorandum will naturally be considered in this connection."

The following quotations from NEEDHAM's memorandum III will not fail to be of interest to all who participate in any national or international conferences in the rôle of science in post-war world organizations: "The present writer's experience during the past two years in China in organizing and directing scientific and technical coöperation between China and the United Kingdom has led him to devote much thought to post-war international scientific coöperation. In two memoranda, the first written in Chungking, July, 1944; the second in London, December, 1944, he worked out a plan for an International Science Coöperative Service (I.S.C.S.) which should take its place beside the other international organizations stemming from whatever supreme world council of nations should take form at the conclusion of the war. The original idea, contained in correspondence with Dr. T. V. SUNG in December, 1943, thus came to take its place within the framework of Dumbarton Oaks . . . The international scientific unions were thus limited as to subject-matter; the bilateral science coöperative offices are limited as to national scope . . . In the future, there are two other types of international scientific intercourse which may grow up. One is the further extension into the scientific field of the bilateral cultural goodwill organizations (such as the British Council, Cultural Division of the U.S. Department of State, etc.). The other is the appointment of scientific attachés in the principal embassies. While there is much to be said for both these methods, the present writer now feels that since it is impossible to rid either of them of a fundamentally national emphasis, and an inevitable national loyalty on the part of the officials concerned, these methods are not fitted to play the major rôle, though they may well play a valuable minor rôle, in the international exchange of so basically international an activity as science . . . The writer has now had the opportunity of a large number of personal conversations with leading scientific men and government officials concerned with science in China, India, the United Kingdom, the United States, Canada and Australia . . . The dependence of all modern world civilization on applied science must find its expression in the sphere of international relations. This desire is more strongly expressed, however, the further one goes away from the United States; and in the United Kingdom it is much more noticeable among scientists under fifty than among those above that age. Some of the older generation, though theoretically in favor of international scientific coöperation, are distrustful of any machinery for doing it . . . The fundamental error of believers in what we may call "laissez-faire", however, is that they look at the scene too exclusively from the European-American point of view, that is to say, they think of oscillating between Paris, Brussels, London, New York, Washington, Montreal, and the like. They do not realise that the picture of world science looks very different when seen from Roumania, Peru, Java, Siam or China . . . The parochial theory of the "laissez-faire" school is that in science everyone knows everyone else, and can therefore easily get in touch when any problem arises which calls for it. But this is simply not the case in the greater part of the world . . . It would obviously be absurd for any international funds to be spent in communicating between people in the United Kingdom and the United States, for example, who are quite well able to communicate with each other . . . The I.S.C.S. should be directed, and indeed limited, to doing those things in international scientific coöperation which are not being done, by any other channels Acceptance of this principle would at once reassure those scientists within the "bright zone" who fear that some bureaucratic organization might come between them and the colleagues with whom they are familiar across the Atlantic . . . An eminent astronomer said to the writer "one assumes that a man has the necessary books and equipment, and then it lies between him and his maker." . . . The spontaneously arising scientific organizations before the war made the great mistake of thinking that

the battle was won when the organization was once written down on paper, and eminent scientists in different countries had accepted high positions in it. There thus grew up what might be called "invisible secretariats", existing on paper, and capable of doing no real work . . . In war-time, no facilities are too expensive for the scientist, no counsels are too high for him to take part in; he is implored, like ARCHIMEDES, to think up something for the nation's salvation. Then, when the tension is relaxed, political and private men alike sink back into the *otium* of an outworn "humanism", oblivious of the rest of human suffering throughout the world which needs the scientist's help just as much as the military survival of democratic nations . . . Since it is impossible to separate natural science either from applied science and technology on the one side, or from the humanistic sciences and philosophy on the other, it would probably be better to maintain the principle that U.N.E.C.O. should be U.N.E.S.C.O. and then to divide the work of an I.S.C.S between the more detailed matters suitable for the higher conciliar level . . . But of the value of having Science (Scientists) able to make its (their) contribution at the higher conciliar level there can be no doubt."

• Chronica Botanica, Volume 9, Number 5-6 •

LUTHER BURBANK

WALTER LAFAYETTE HOWARD *was born May 12, 1872, near Springfield, Missouri. B. Agr., B.S., University of Missouri, 1901, M.S., 1903; studied University of Leipzig, 1905, Ph.D., University of Halle-Wittenberg, 1906. Studied at East Malling Research Station, England, 1930. Assistant horticulturist, Experiment Station, University of Missouri, 1901-03, Instructor, 1903-04, Assistant Professor of Horticulture, 1905-08, Professor, 1908-15; Associate Professor of Pomology, University of California, 1915-18, Professor, 1918, head of Division of Pomology, 1922-29, Acting Director, Branch of the College of Agriculture, 1924-25, Director 1925-37, Professor Emeritus since 1942. Investigated horticultural problems in France and contiguous countries, 1921-22. Secretary Missouri State Board of Horticulture, 1908-12. Member, Jury of Awards San Francisco Exposition, 1915. Fellow A.A.A.S., member American Genetic Association, American Society of Horticultural Science, American Eugenics Society, Sigma Xi, Alpha Zeta, Sigma Kappa Zeta. Croix de Chevalier du Mérite Agricole, 1934.*

Luther Burbank

A Victim of Hero Worship

by

Walter L. Howard, Ph.D.

Emeritus Professor of Pomology, University of California; late Director, College of Agriculture of the University of California, at Davis, Calif.

"Extravagant estimates of my work have been the bane of my existence. There has been much written about me by sensational writers who know nothing either of me or my work. I am not responsible for all these things and anyone with any knowledge of horticulture could discern at once that much of the stuff sent out is nothing but the space-writer's chaff . . ." (Luther Burbank).

A unique, great genius . . . (Hugo de Vries).

CONTENTS

The vignette on the title page shows the sandy, rolling land of Luther Burbank's experimental farm where all his fruits were tested before offering them for sale. The countryside here is lovely.

PROLOGUE

The character sketches which make up this book have been prepared in a spirit of fair play to enable the reader to understand and appreciate LUTHER BURBANK. *Circumstances over which he had little control clothed him in glittering tinsel, but a veil of darker hue was superposed when he became the tool of schemers. Temperament, eccentricities, and unwise talk — all nonessentials and unimportant — added to the confusion and helped to warp the judgment of observers. This was particularly true of those who had to reach conclusions at second hand.*

With none too gentle hands I have endeavored to tear away these hindering habiliments to see what the real BURBANK *looked like. And behold, a pristine figure emerges that is every inch a man of worth, a man of original ideas; a man with a definite mission in life, fully capable of standing on his own feet as a lone worker in the field of science.*

It is impossible to evaluate BURBANK'S *accomplishments with finality, but they were many and diverse, some direct, some indirect. Delving into details, the historian is amazed at the multiplicity of things that one man could do. With prejudice excluded, there still will be honest differences of opinion regarding the scientific value of his work. Liberals will concede much, the punctilious may equivocate.*

I have to thank the following libraries for the loan of rare BURBANK *publications — his catalogs and price lists: United States Department of Agriculture, Washington, D. C.; the Massachusetts Horticultural Society, Boston; the New York State Agricultural Experiment Station, Geneva; the New York State College, Department of Pomology, Ithaca; and the Missouri Botanical Garden, St. Louis. Professor* W. L. JEPSON *of Berkeley, California, contributed duplicates from his personal library. Other memorabilia — letters, pamphlets, clippings, photographs — were loaned or contributed by* H. E. V. PICKSTONE AND BROTHER, *Simondium, Cape of Good Hope, South Africa (complete file of correspondence with* BURBANK *for 29 years)*; VILMORIN-ANDRIEUX ET CIE., *Paris, France; the firm of* METTE, *Quedlinburg (oldest of German seedsmen, still handle* BURBANK *products), and* ERNST BENARY *of Erfurt, Germany;* J. J. H. GREGORY AND SON, *Marblehead, Massachusetts, and* MILLARD SHARPE *of Vacaville, California. Mrs.* BURBANK *kindly permitted me to examine in detail the 17-volume scrap book kept by* BURBANK *for fifty years, for which I am grateful. Finally, I am greatly indebted to the following persons for personal and professional information about* BURBANK: *Dr.* D. P. ANDERSON, *Mr.* FRANK DOYLE *and Miss* PAULINE OLSON *of Santa Rosa, California; Prof.* J. E. CHENOWETH *of Bakersfield, Mr.* WILL HENDERSON *of Fresno, and Mr.* W. I. BEESON *of Sebastopol, California; and especially to Dr.* GEORGE H. SHULL *of Princeton, New Jersey. I regret that it is not feasible to mention the scores of others from California and elsewhere who contributed bits of information. The old Scottish Lowland proverb was right, "many littles [do indeed] make a much".*

I

INTRODUCTION

ABOUT seventy years ago an ambitious young devotee of the gentle art of horticulture was beginning a career that was to lift him to heights of fame undreamed of in his most sanguine moments. During this career he was destined to taste the heady sweets of popular acclaim, as well as the ashes of disillusion. His critics were relentless, but to a host of admirers he was a benefactor, a knight in shining armor. This man was LUTHER BURBANK, erstwhile gardener from Massachusetts, who chose the new land of California as the locale for making his fortune, not in the mines but in the strange vocation of plant breeding. Had he given a name to his calling, which he did not, he doubtless would have termed it plant improvement or plant betterment.

As a dealer in plants — a nurseryman if you please — he was unorthodox, did unusual things: experimented with plants, built up a profitable business, and attained a nation-wide reputation, all without the expenditure of a dollar for publicity purposes. He claimed to be a humanitarian, engaged in the promotion of human welfare, not interested in money. Whether he was a success in advancing the art and science of his craft, as loudly proclaimed by his supporters, or contributed valuable plants to the world were subjects of endless and often bitter controversy. He was both praised and condemned, even accused of hoodwinking a credulous public.

Proponents and opponents had their say but no one attempted to study his career objectively. Mostly, one simply believed in BURBANK or did not. To argue was to be branded as a partisan. The situation was further complicated when exploiters brought his name into their schemes; his religious views were the subject of vitriolic debate. A national Foundation made a try at garnering the scientific results of his work but did not make known its findings. So nothing was settled.

My interest in BURBANK began in 1932 when I undertook to compile a list of his plant productions — that is, new varieties — which he had at one time or another offered for sale. The task grew and grew, until it developed into a full-fledged study of his life. Instead of being concluded in a few weeks or months, the research extended over a period of ten years. New material was encountered concerning the man himself, things that people had asked me about, and which had intrigued my own curiosity. I found the explanation to so many things not before understood that I am impelled to pass the knowledge along to others who, no doubt, will appreciate factual information about BURBANK.

Sources of my information were BURBANK's writings and what others had to say about him over a period of forty years. Added to this I had the testimony of dozens of persons who knew BURBANK, who had served him in one capacity or another, had had business dealings with him, or merely were spectators on the sidelines. These last often were only casual acquaintances of BURBANK — met him in church, lodge meetings, or greeted him on the street — but they knew much about his business and household affairs, for it must be remembered that Santa Rosa, forty years ago, was but a small country town. Helpful interpreters of things that had appeared in print, they were able to restore the original flavor to incidents which had dimmed through lapse of time.

Having accumulated too much indispensable material for a single volume, I lopped off the technical part, which has been lately published by the University of California Agricultural Experiment Station, as a public document, with the title: *Luther Burbank's Plant Contributions.* This will be of interest to gardeners and plant lovers. A summary occurs here — in Chapter XIX.

In relating my human interest story of BURBANK no attempt has been made to write a conventional biography. That has been done several times already, and in one instance — *Harvest of the Years* by HALL — very successfully. My aim has been to explain and clarify some of the principal episodes of his life. To this end, a number of seemingly unrelated topics or episodes were selected for discussion. These encompass the main events of his life, most of them controversial. Some may appear like opéra bouffe, yet they were seriously — and furiously — debated at the time. For purposes of driving home important points, repetition seemed unavoidable. More than one episode might be employed to emphasize the same point; for example, the subject's egotism.

I have been disturbed by the attitude of some of my valued correspondents. They assumed that my object in writing this story was to debunk BURBANK. This was not my purpose at all, any more than it was to debunk his critics; but if telling what appears to be the truth tends to bring him down to earth at times, all I can say is that other characters in the story will be exposed to the same hazard.

Despite all that has been written about BURBANK, the average citizen still yearns for the truth. Friend and foe alike have expressed this thought. The inference is clear. This lays a heavy responsibility upon the reporter who would record with fidelity the major occurrences in the life of a stormy petrel like LUTHER BURBANK. For who is wise enough to discern the truth under all circumstances? Certainly it is not always a simple question of veracity. In the BURBANK case, with its maze of conflicting versions of this or that incident, conclusions had to be arrived at through judgment and interpretation of motives. Even ethics had to be taken into account.

Custom has its weight and plays its part. Truth appears to be elastic: in moments of enthusiasm we are sometimes said to

stretch the truth. Of course, this is an euphemistic way of saying that we are exceeding the truth. Exaggeration, although a perversion of the truth, is widely tolerated. We employ exaggeration in our social conversation. We have our daily portion of it in the newspapers. We read it in the advertisements, and the ether waves quiver with it. Deplore it, yes, but accept it we must.

Logically, truth should be factual; but facts as applied to a situation or occurrence that took place thirty to forty years ago are as elusive as fleas. They are not only hard to capture but are difficult to evaluate. Fiction creeps in. To change the metaphor, tares become mixed with the grain, and there is the chaff to contend with. In the course of this inquiry there has been much sifting and winnowing and fumigating.

An effort has been made to take into consideration and make proper allowance for individual viewpoint, personal prejudice, envy and professional jealousy; for all these conditions have been encountered in the course of the BURBANK studies. A colorful character like BURBANK stirred many people, aroused diverse emotions. They reacted according to their viewpoint and training. First, there were the men of science in our schools and research institutions. Broadly, these may be divided into two groups: the older, general scientists, and the younger specialists who have grown up since 1900. The first, in the main, are tolerant, kindly disposed toward BURBANK and concede that he really accomplished much both directly and indirectly. The younger men are apt to judge him by the criterions they apply to themselves, their colleagues and contemporaries, and, consequently, reach the conclusion that he did not measure up as a scientist because he did not use the tools and standards which they employ: in short, that he does not rate at all, and is not worth considering. This group includes most of the geneticists now in active life.

Then there are the thousands of teachers in our American grade schools who have the training of our children during their most impressionable years. These have always idealized BURBANK and have often portrayed him as a sort of superman. I have contacted hundreds of these teachers all over the United States, and almost without exception they give him credit for possessing all the virtues and not a single fault. Many have supplied me, in great detail, with the kind of information they are giving. Their information is based on what they have read about BURBANK in the newspapers, magazines, Sunday supplements, and especially HARWOOD's magazine articles[1] and book[2]. Many of BURBANK's best friends have told me that it was unfortunate the book ever

[1] HARWOOD, W. S., A maker of new plants and fruits. Scribner's Magazine, New York, July, 1904. — A wonder worker of science. Century Magazine, New York, 69: 656, 672, 821, 837. 1905. — LUTHER BURBANK's achievements. Country Calendar, Harrisburg, Pa., 1, 3: 244, July, 1905. — How LUTHER BURBANK creates new flowers. Ladies Home Journal, Philadelphia, Pa., May, 1907.

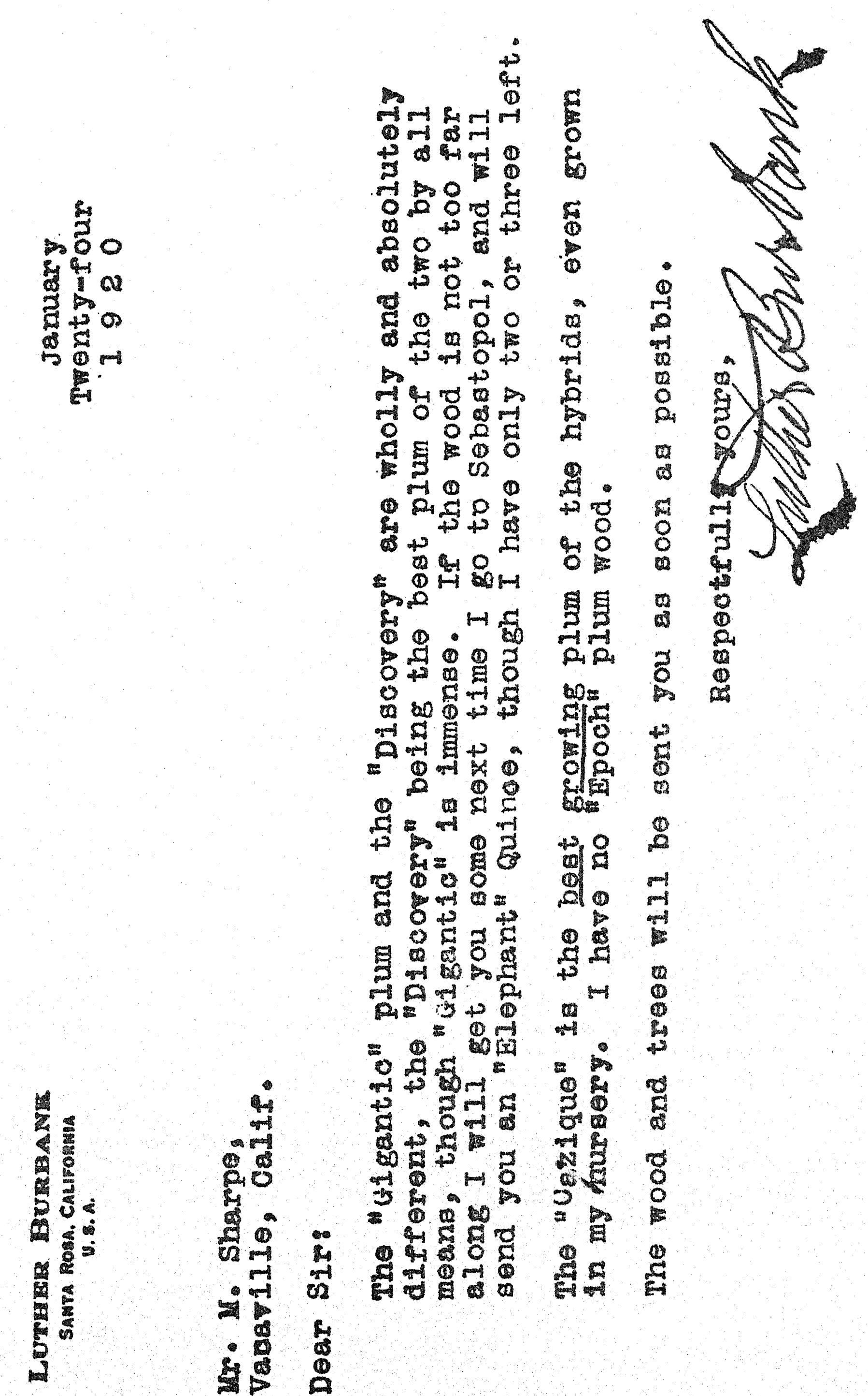
[2] HARWOOD, W. S., New creations in plant life; an authoritative account of the life and work of LUTHER BURBANK. 2nd ed. The Macmillan Company, New York, 1907.

was published. Under the treatment of this author, everything that BURBANK had done was played up as a marvel of accomplishment, often bordering on the supernatural. A discriminating reader, it is true, could pick out the grains of truth, smile at the exaggerations. The sentimental and the uninformed, however, are apt to accept the intemperate statements as facts, as the author doubtless intended they should do. If the book had come under the provisions of the National Pure Food Law it would have been necessary to entitle it "New Creations in Plant Life — A Fairy Story". HARWOOD delighted in making astonishing statements: "BURBANK has disproved MENDEL's work on peas, and also disproved DE VRIES' theory of mutants. . . . Here, as in hundreds of cases all through his career, the 'laws' have been shown not to apply, save in rare instances, by the evidence accumulating in the tests carried on upon so colossal a scale. . . . He would welcome, with the eagerness of any lover of truth, any confirmation of law, for his whole life is pledged to law. He had no ulterior purpose in disproving Mendelian laws: in point of fact, he had disproved their universal applicability years before he knew they existed. Mr. BURBANK, in another instance, has brought to light the absurdity of reasoning from inadequate data. Leading scientists have maintained, and their followers have added the weight of their evidence, that 'acquired characteristics are never transmitted.' In the limitless fields of operation before him, Mr. BURBANK has not only disproven this over and over again, but has established the opposite, that acquired characteristics are the only ones that are transmitted."

I do not mean to deny that the book related many of the actual happenings in BURBANK's professional life. It did. But most of these happenings were served up in a decidedly misleading manner. I cannot exactly say that they were falsehoods, because they were all based on facts; but they leave a false impression. The harm done by HARWOOD's writings about BURBANK has therefore been of an insidious nature, such as a tricky lawyer likes to defend in a court of law because it is difficult to prove the absolute falsity of the statements. For example, in speaking of the Paradox walnut produced from crossing the cultivated English walnut with the native Northern California Black walnut, which did grow much more rapidly than other walnuts, he says:

"At the end of 12 years each tree will be worth approximately $80. The acre yield would be $2880. For an average farm of 160 acres the revenue for the 12 years with no outlay, save the cost of planting (not over 25 cents per tree), taxes upon the land, and interest on money invested, would be a little over $460,000. This does not take into fact the value of the branches and the refuse slabs of mill sawing which would amount to at least four cords per tree — about $24,000 for the total trees or a grand total for the 160 acres for lumber and fuel amounting to $485,000."

Sounds like a page out of Gulliver's travels, does it not? But who could disprove it? We might think that no one in his right



LUTHER BURBANK
SANTA ROSA, CALIFORNIA
U. S. A.

January
Twenty-four
1 9 2 0

Mr. M. Sharpe,
Vacaville, Calif.

Dear Sir:

The "Gigantic" plum and the "Discovery" are wholly and absolutely different, the "Discovery" being the best plum of the two by all means, though "Gigantic" is immense. If the wood is not too far along I will get you some next time I go to Sebastopol, and will send you an "Elephant" Quince, though I have only two or three left.

The "Oazique" is the best growing plum of the hybrids, even grown in my nursery. I have no "Epoch" plum wood.

The wood and trees will be sent you as soon as possible.

Respectfully yours,

Luther Burbank

TEXTFIGURE 1.—TYPICAL BUSINESS LETTER AND AUTOGRAPH OF BURBANK.—MILLARD SHARPE, nurseryman, fruit grower, amateur breeder of fruits and an authority on plum and cherry varieties, was acquainted with Mr. BURBANK for twenty years; often visited his experimental gardens, and made a point of testing his new fruits as they were announced. An expert himself, SHARPE greatly admired BURBANK's skill and acumen, both as a propagator and a breeder.

mind would accept such an absurd statement, but unfortunately there were plenty of people who would accept it. For the most part, people with no experience whatever in agriculture thought they saw a chance to make a fortune overnight. But this was not the worst harm that was done: it was in the way BURBANK's experiments were described, which resulted in the production of hybrid plants. Whether or not they possessed intrinsic value was of less importance than the alleged mysterious way in which the experiments were performed: for there is no mystery about the crossing of two plants, the hybridizer is no magician, and it is a shame that a legend should grow up around an individual that could make him a magical figure. Scientists and other informed people were disgusted and immediately branded BURBANK as a faker because they said we are not living in an age of miracles, meaning that anyone claiming to be in league with the supernatural lays himself open to grave charges.

On top of this BURBANK was portrayed by various writers as a man of sweet disposition, a sort of little Lord Fauntleroy grown-up, that took him completely out of the ranks of work-a-day men. As a matter of fact, BURBANK had enough faults along with his virtues to make him human, but HARWOOD set the pace in portraying him as a man of mystery with his head in the clouds so that others felt that they must trail along and not spoil the picture.

Teachers of children have ever sought noble characters to hold up as heroes for them to emulate, and BURBANK's life supplied material in abundance for this purpose. No harm would have been done by depicting him as a noble character, but coloring was added that eventuated into his becoming a cult. Elementary teachers everywhere found his life and works to be just about perfect for their purposes.

When I first began my BURBANK studies, I experimented with my college students by asking them about BURBANK. I soon discovered that all had approximately the same information, and their views of BURBANK fitted into a certain pattern. Upon closer inquiry it was found that most of them had obtained such information as they had from instruction received when they were 11 or 12 years old. Having traced most of their information to the grammar school teacher, I then made a wide survey of elementary teachers and found that the BURBANK fictions began to be disseminated along about 1905 and that a whole generation of men and women have grown up with their grammar school instruction as the only information they have about the man. Here and there a boy would confess that when he got into high school and started to study science, he began to doubt some of the ideas he had acquired in grammar school. In college, these boys came into contact with instructors who belonged to the ranks of modern geneticists, where they were given an entirely new picture of BURBANK, which in most cases was as far wrong as their first one.

There are literally tens of thousands of children who are indoctrinated with the BURBANK fairy story every year, and I can

see no end to it. Rightly guided there is nothing serious about this, but it is unfortunate that a whole population should be allowed to grow up with false notions about a man who was really useful in his generation. Many of these people in later life hear the other side of the story, and the effect upon them is that of a boy who loses his childhood faith in religion — that is, he is apt to become a cynic.

I originally embraced the fond hope that I could bridge the chasm between the extreme admirers of BURBANK and those who deprecated him. But the trouble, I found, was that when we worship a hero, we do not care to have our idol shattered; and if we have heard a man condemned often enough to bring belief, we do not relish having proof thrust in our faces that we are all wrong. Fortunately, there appears to be a host of people who have no violent feeling about BURBANK one way or the other and who merely want the honest facts about the man and his life work, his value to human society as a whole, not alone to the science of plant breeding.

It has been my purpose to try to supply this information, but in so doing, I am surely aware of the fact that what I shall say will not please either faction. However, I console myself with the thought that hereafter trained readers at least will follow the scientific plan of studying all sides of a man before making up their minds about him. If I shall have supplied information not heretofore obtainable about BURBANK that will help students to arrive at their own conclusion after all evidence is in, then I shall feel that I have not labored in vain.

II

THE BACKGROUND

FEW MEN in private life have become so widely known as was LUTHER BURBANK of Santa Rosa, California. Through the printed page and by word of mouth the name has been disseminated the world around. The name is always associated with plant improvement or the production of new varieties of fruits and flowers. Legends have grown up about him and his ability to do marvelous, if not impossible, things with plants. Careless writers and speakers have woven so many fairy tales around the name and fed them so widely to innocent children, as well as to ignorant and uninformed adults, that the present generation is faced with the dilemma of swallowing the stories whole or rejecting everything it has heard about the man. By and large, the thinking members of the public are kindly disposed toward BURBANK, but incredulous. Sometimes they are downright suspicious. But the great majority would like to have the facts because they are frankly curious. They want to know what the man was like, about his home life, his daily work, his relations with other people, and whether he was human or a freak. Special groups want to know about his horticultural attainments and techniques. Still others want to know what percentage of his output has made good. The final question — and it is clear that it was often uppermost in the minds of all — was whether he was an honest man or a trickster.

When I first came to California, eleven years before BURBANK's death, I received numerous letters from friends in the Eastern and Middle States asking me for information about the man. At that time I had a rather wide acquaintance in horticultural circles throughout the regions mentioned and these friends believed or hoped that I was in a position to give them the low-down about BURBANK. I went to see him and also talked with my associates. They were not very informative. Their smiles were misleading. Without background of the BURBANK situation, I now realize that they were smiling at my ignorance and seeming naïveté. The main era of BURBANK's exploitation was then at its peak. A newcomer couldn't be expected to understand — and didn't.

Unfortunately I did not make use of my opportunities by starting my studies of BURBANK and his horticultural accomplishments while he was still alive, for much salient information is now lost, particularly leads that might have enabled me to trace many of his hybrid plant productions that were sold unannounced and without names. Also I might now have a better picture of the man himself. On the other hand, I might have fallen into the rut

that other interpreters had followed which has not proven to be very helpful to a world that is still befuddled. The objective view is often best, so I console myself with the thought that perhaps a truer evaluation of the man can be made now, nearly two decades after his death, even with some data missing, than would have been possible while he was still here to give information, but with the greater danger of having my judgment warped by personalities. A shrewd man who had successfully battled his way to high places in political life once warned me never to undertake to judge a baby show while the infants were being held in their mother's arms!

After all, BURBANK's output of improved plant forms was so extensive that I feel the few score, or possibly few hundreds, of forms that I have not been able to find records of would not materially change his rating. But just what he produced or how many of this, that, or the other he turned out is not the big question in the minds of the multitude of people who want to know about BURBANK. No, indeed. For example, in 1931 a controversy about BURBANK arose in the public schools of a large city on the Atlantic seaboard. A science teacher happened to pass a room where a primary teacher was telling her class of little folk about LUTHER BURBANK. The first words that reached him arrested his attention and he stopped to listen. The things he heard rooted him to the spot in amazement. When the class was dismissed he took the lady to task, telling her that although he did not claim to know anything about BURBANK — in fact, was only barely familiar with the name — he was quite sure the things she had been telling her children could not possibly be true, that we were not now living in an age of magic and fairy tales, etc., etc. The lady was very indignant, claimed that she was right, and advised the man to study up on BURBANK and inform himself on the marvelous things that he had done. Other teachers took sides in the argument and the battle was on. For the most part it was the men *versus* the women teachers. The arguments of the former were based upon rationalism while the latter defended their position on sentimental grounds. The controversy was finally referred to the principal who, in bewilderment, pronounced that both sides could not be right and referred the question to Professor L. H. BAILEY of Cornell University; he promptly passed it on to me with the helpful suggestion that I was located in California and quite near BURBANK's home, and therefore should be in a position to obtain the facts about the man and his accomplishments!

I sent a letter to the principal in which I sketched the highlights of the controversy about BURBANK that had prevailed throughout the United States and a few foreign countries many years earlier and pointed out that neither the admirers nor the disparagers of BURBANK were entirely right, that the truth lay somewhere between the two extremes. My reply evidently checked this particular controversy (as I heard no more about it) but I dare say no one was convinced. The incident, however, served to crystallize a thought that had been forming in my mind for some time, namely,

that it was high time that some one obtained the facts and made a fair and impartial evaluation of BURBANK and his accomplishments. What a job this would have been for the master hand of Professor BAILEY! But he was not available and I reluctantly undertook the task. This was in 1932. For five years I did what I could, working part time; then in 1937, having been relieved of some of my official duties I took up the work in earnest.

My personal acquaintance with Mr. BURBANK was limited to a one-half day visit with him in the summer of 1915. Although for thirty years I have resided near the BURBANK place (86 miles distant), I do not believe anyone can successfully accuse me of personal bias because of my relative proximity to the man and his establishment. Also I can affirm that my mind has always been free of prejudice. As a student at the University of Missouri I was chiefly under the influence of the late Professor WHITTEN of beloved memory, who never uttered an unkind word about anyone because in his great soul there was no room for malice or envy. Even when the country was flooded with the literature of the so-called Luther Burbank Society about 1912 or 1913, which was misleading and quite evidently insincere, he remained calm and allowed all of us to draw our own conclusions, if any.

When I came to California in January, 1915, I cannot recall that I held any definite opinion of BURBANK, but I was mildly curious. The one time I called upon him satisfied much of my curiosity. He frequently announced that he did not want visitors unless they came by appointment and then they would not be admitted to his experimental grounds at Sebastopol. I did not seek an appointment because of the possible use he might make of my connection in his advertising literature; not that I was a notable, but the institution I served was.

While I knew in a general way that the high-powered promoters and exploiters of BURBANK — the Luther Burbank Company and the Luther Burbank Press — were then in process of defaulting, with a train of disillusioned stockholders mourning their losses, I did not know how the BURBANK business was being conducted; and as it was more or less in disrepute, I thought the safe thing was to keep away.

Perhaps, as I now look backward, I was unduly alarmed, but I was particularly sensitive at the time as I had just passed through the experience of being tricked by a conscienceless promoter into a seeming endorsement of a shady land selling scheme. I visited the place in a private — and as I thought, anonymous — capacity, but he accidently discovered my identity and used me, or rather the University, accordingly. Also I had been imposed upon a few years earlier by a large nursery that was rated as respectable, but which was given to making unduly extravagant claims for its wares.

Then there was the case of Professor E. J. WICKSON, who was head of the Department of Horticulture in the University of California and for many years Dean of the College of Agriculture

NEW CREATIONS

IN

Fruits and Flowers,

JUNE, 1893.

KEEP THIS CATALOGUE FOR REFERENCE.

You will need it when these Fruits and Flowers become standards of excellence.
Supplementary Lists will be published from time to time.

BURBANK'S EXPERIMENT GROUNDS,

Santa Rosa, California, U. S. A.

Office and Residence:
204 Santa Rosa Avenue.

Cable Address:
"Burbank, Santa Rosa, Cal."

"NEW CREATIONS IN FRUITS AND FLOWERS, JUNE, 1893." — This 52-page, illustrated catalog was the most important announcement ever made by BURBANK. His fame as a plant breeder was now established, both nationally and internationally. Ten or twelve years earlier when he first began sending out his new fruits, buyers were hesitant because he was unknown. Now with the announcement of many new hybrids, scientific men began to take notice and enterprising nurserymen were anxious to procure some of the things that were being so widely talked about.

In his next year's catalog (1894), under the same title, BURBANK reviewed the situation as follows: "Twelve months have passed since the first number of 'New Creations in Fruits and Flowers' was sent out on its mission among dealers in trees and plants, great care being taken to confine it to the trade only; but before the few hundred first published were all delivered, orders came pouring in with each mail, like the falling of autumn leaves, for more, more, and again more had to be printed, and to this day the requests for 'New Creations' are increasing rapidly, instead of diminishing, as it had been hoped they would.

"Probably no horticultural publication ever created more profound surprise or received a more hearty welcome. Almost every mail brings requests for them from colleges, experiment stations, libraries, students, and scientific societies in Europe and America, and it has been translated into other languages for foreign lands, even where it would seem that scientific horticulture was hardly recognized; some asking for one, others for two or three, or a dozen or two or more. We cannot attend to the ever increasing avalanche of letters which they occasion, a large portion of which are from amateurs, with long lists of questions, which would require years, perhaps a lifetime, to answer.

"This ever increasing number of letters, which we have always carefully replied to (some twelve hundred to two thousand per annum), must be stopped, in part at least, else there will soon be no one here to answer them. We love to produce new fruits and flowers, and our heart is made glad beyond expression to know that our work is appreciated far and wide; but most of the *questions* which amateurs ask could better be answered by some horticultural paper, which would welcome them, or some one who has more leisure at his command . . . .

"We would very much prefer to have all our new fruits and flowers fully tested everywhere and by everybody [before sending them out]; but those who know the facts are too well aware that it would be a perilous risk or utter ruin to the originator, as a single bud or seed in the wrong hands may place an unscrupulous person on an equal footing with the originator, who may have spent worlds of patient thought and toil, during the few short years of the best of his life, in producing the beautiful creation . . . . .

"Do not imagine that because the purchaser of the control of any of our new fruits and flowers happens to be so enthusiastic as to overpraise them, painting their virtues in far brighter colors than we have done, that the originator should be blamed. Great loss, vexation and disappointment come from indiscriminate and unwarranted praise . . . ."

and Director of the Agricultural Experiment Station, as well as editor of an agricultural paper. From the very beginning he seems to have been very friendly toward BURBANK and sympathetic toward his work, visited him, wrote many articles about his work, all highly laudatory, and was honored by BURBANK who named a plum after him. These relations continued until a few years after the turn of the century when WICKSON seems to have dropped his friend. Whether the extensive use of his name in the BURBANK advertising literature had anything to do with it I do not know, and it is now too late to find out. However, that was the gossip among his colleagues, who, in truth it must be said, were not acquainted with BURBANK and did not care to be; although, they were curious and would have liked to have seen BURBANK and his place but were afraid of being used. Perhaps WICKSON liked to have his name used so widely. I am inclined to think that he did. As a newspaper man he presumably believed in publicity. He was not a scientist *per se* so he had none of the inhibitions of the scientist regarding personal publicity. But along about 1910 or 1912 or thereabouts, he seems to have tired of it and ceased both his writings and his visits.

When I visited BURBANK I went with a party of three or four members of the American Pomological Society, who were in California to hold their annual meeting and visit the Panama-Pacific Exposition then being held in San Francisco. These men, who had made an appointment to see BURBANK, had to leave after an hour or so, but I wanted to stay longer. In leaving they introduced me as being from the University of California. BURBANK was exceedingly cordial — more so than before — and immediately undertook to entertain me by showing me all the interesting things in the old home garden. Then we went across the street to the roomy, two-story house which he had built in 1907, "from the proceeds of a sale of spineless cactus to a dealer in Australia," and which was his residence for the remainder of his life. Here he showed me how he kept his seasonal records of some apples he was just then particularly interested in, as well as the system of marks and hieroglyphics he used in noting the different grades of approval or disapproval of other fruits under trial, but if he kept any permanent records or yearly summaries, he did not show them, and as far as I could see he kept no written account of the parentage of his crosses. He left me to browse among his records — more properly, random-notes — while he attended to some matters with his secretary. This young lady, I might mention in passing, did not look upon my presence with approval, and when we started for the yard another secretary, this time a young man, said something to Mr. BURBANK which he dismissed with a wave of his hand.

The house occupied a corner lot, and I noticed that both sides of the intersecting streets were lined with cars and a great crowd was milling around looking over the low picket fences but not daring to enter either of the gardens. As we came out Mr. BURBANK was the cynosure of all eyes and the visitors lined up against

"New Creations in Fruits and Flowers, June, 1893."—This 52-page, illustrated catalog was the most important announcement ever made by Burbank. His fame as a plant breeder was now established, both nationally and internationally. Ten or twelve years earlier when he first began sending out his new fruits, buyers were hesitant because he was unknown. Now with the announcement of many new hybrids, scientific men began to take notice and enterprising nurserymen were anxious to procure some of the things that were being so widely talked about.

In his next year's catalog (1894), under the same title, Burbank reviewed the situation as follows: "Twelve months have passed since the first number of 'New Creations in Fruits and Flowers' was sent out on its mission among dealers in trees and plants, great care being taken to confine it to the trade only; but before the few hundred first published were all delivered, orders came pouring in with each mail, like the falling of autumn leaves, for more, more, and again more had to be printed, and to this day the requests for 'New Creations' are increasing rapidly, instead of diminishing, as it had been hoped they would.

"Probably no horticultural publication ever created more profound surprise or received a more hearty welcome. Almost every mail brings requests for them from colleges, experiment stations, libraries, students, and scientific societies in Europe and America, and it has been translated into other languages for foreign lands, even where it would seem that scientific horticulture was hardly recognized; some asking for one, others for two or three, or a dozen or two or more. We cannot attend to the ever increasing avalanche of letters which they occasion, a large portion of which are from amateurs, with long lists of questions, which would require years, perhaps a lifetime, to answer.

"This ever increasing number of letters, which we have always carefully replied to (some twelve hundred to two thousand per annum), must be stopped, in part at least, else there will soon be no one here to answer them. We love to produce new fruits and flowers, and our heart is made glad beyond expression to know that our work is appreciated far and wide; but most of the *questions* which amateurs ask could better be answered by some horticultural paper, which would welcome them, or some one who has more leisure at his command . . . .

"We would very much prefer to have all our new fruits and flowers fully tested everywhere and by everybody [before sending them out]; but those who know the facts are too well aware that it would be a perilous risk or utter ruin to the originator, as a single bud or seed in the wrong hands may place an unscrupulous person on an equal footing with the originator, who may have spent worlds of patient thought and toil, during the few short years of the best of his life, in producing the beautiful creation . . . . .

"Do not imagine that because the purchaser of the control of any of our new fruits and flowers happens to be so enthusiastic as to overpraise them, painting their virtues in far brighter colors than we have done, that the originator should be blamed. Great loss, vexation and disappointment come from indiscriminate and unwarranted praise . . . ."

and Director of the Agricultural Experiment Station, as well as editor of an agricultural paper. From the very beginning he seems to have been very friendly toward BURBANK and sympathetic toward his work, visited him, wrote many articles about his work, all highly laudatory, and was honored by BURBANK who named a plum after him. These relations continued until a few years after the turn of the century when WICKSON seems to have dropped his friend. Whether the extensive use of his name in the BURBANK advertising literature had anything to do with it I do not know, and it is now too late to find out. However, that was the gossip among his colleagues, who, in truth it must be said, were not acquainted with BURBANK and did not care to be; although, they were curious and would have liked to have seen BURBANK and his place but were afraid of being used. Perhaps WICKSON liked to have his name used so widely. I am inclined to think that he did. As a newspaper man he presumably believed in publicity. He was not a scientist *per se* so he had none of the inhibitions of the scientist regarding personal publicity. But along about 1910 or 1912 or thereabouts, he seems to have tired of it and ceased both his writings and his visits.

When I visited BURBANK I went with a party of three or four members of the American Pomological Society, who were in California to hold their annual meeting and visit the Panama-Pacific Exposition then being held in San Francisco. These men, who had made an appointment to see BURBANK, had to leave after an hour or so, but I wanted to stay longer. In leaving they introduced me as being from the University of California. BURBANK was exceedingly cordial — more so than before — and immediately undertook to entertain me by showing me all the interesting things in the old home garden. Then we went across the street to the roomy, two-story house which he had built in 1907, "from the proceeds of a sale of spineless cactus to a dealer in Australia," and which was his residence for the remainder of his life. Here he showed me how he kept his seasonal records of some apples he was just then particularly interested in, as well as the system of marks and hieroglyphics he used in noting the different grades of approval or disapproval of other fruits under trial, but if he kept any permanent records or yearly summaries, he did not show them, and as far as I could see he kept no written account of the parentage of his crosses. He left me to browse among his records — more properly, random-notes — while he attended to some matters with his secretary. This young lady, I might mention in passing, did not look upon my presence with approval, and when we started for the yard another secretary, this time a young man, said something to Mr. BURBANK which he dismissed with a wave of his hand.

The house occupied a corner lot, and I noticed that both sides of the intersecting streets were lined with cars and a great crowd was milling around looking over the low picket fences but not daring to enter either of the gardens. As we came out Mr. BURBANK was the cynosure of all eyes and the visitors lined up against

the fence on our side of the street to gaze upon him. As we moved about examining this and that tree or shrub I was ill at ease and embarrassed because I felt unworthy of so much attention. If BURBANK was in the least self-conscious he did not show it; on the contrary, he seemed to enjoy the situation. I soon noticed that a male secretary was hovering around as though he would like to speak to Mr. BURBANK. I say "hovered" because he forcibly reminded me of a negro in the "black belt" of Texas when he wants to say something to a white man but must wait for an invitation. At length BURBANK looked his way and curtly asked, "Well, what is it?" The young man came closer and whispered something but was impatiently dismissed with some remark to the effect that he was busy and could not be disturbed. Noticing how crestfallen the man was, I seized an early opportunity to say that I must be going. Then BURBANK broke out pettishly that he could spend as much time with a visitor as he wanted to, that I was from the University and had never been there before. Then, "Why haven't you visited me before? Why is it you people don't visit me oftener? Professor WICKSON used to come to see me and now even he doesn't come any more. What have I done, etc., etc. " I had noticed out in the street a huge, shiny car, with a man dressed in a morning coat and top hat, surrounded by an escort of men also in formal dress, and in my confusion I sought to change the conversation by remarking that some distinguished visitors wanted to see him and that I was taking altogether too much of his time. Without looking around, he remarked, "Huh, that's only the Governor of Pennsylvania; let him wait." He then began to explain, and it was really pathetic — though naïve — that so many people came to see him through curiosity only that he felt like a monkey in a cage, that he was sick and tired of it, and that now, while the Exposition was going on, there were simply swarms of them. "What am I to do? If I undertake to see them I can do no work, and if I turn them away they are resentful and say unkind things about me. How am I to know when I am turning away people that I would really like to see? You didn't make an appointment with me today, and you might have been refused admittance. How am I to know? What am I to do?"

Previously, during the hours I had spent with him, he had been cheerful and in good spirits and positively glowed as he described the superior qualities of some of his "creations", but now as the hopelessness of his situation came over him, he looked tired and discouraged — like an old, old man — and I felt sorry for him and deeply sympathetic.

III

BURBANK THE MAN

IN PERSONAL appearance BURBANK was of medium height and build with florid complexion and a full head of hair. He was referred to by DE VRIES and others as being small or slight, but in my limited acquaintance with him he did not impress me as being either small or slight, but just medium. As a matter of fact, his widow tells me he was about 5 feet 8 inches tall and weighed around 150 pounds. While not very robust, he was wiry, highly sensitive, always alert, and inquisitive. He referred to himself at the time he arrived in California, when he was 26 years old, as being a "small, wiry, active young man." One of his biographers[3] described him, when he was near the end of his long life, that is, at the age of 76, as being "small, live, and slightly stooped; his eyes a deep, placid blue. Of a nervous temperament and with a vital, compelling personality, he always impressed visitors with his sincerity of purpose."

All his adult life he was playful, whimsical, sometimes grumpy, and from the middle eighties on became increasingly egotistical. Under normal conditions his disposition was mild, even gentle, but persons who have worked for him say that on occasion when exasperated at someone's carelessness or stupidity in injuring or destroying a valued plant, he might fly into a passion and use forceful language with an earthy flavor befitting the circumstances. WILL HENDERSON, who worked for BURBANK from 1922 until the latter's death in 1926, relates[4] that they were discussing some matter out in the yard one day when a man leaped the low picket fence, rushed up to the pair and, sticking out his hand, exclaimed: "Well, well, this is Mr. BURBANK, I am sure, and I am so glad to meet you and I suppose this is the young man who is to be your successor, is it not?" BURBANK glared at the intruder, and snapped out, pointing to the gate, "It's none of your damn business and get the hell out of here."

WALTER B. CLARKE, a California nurseryman, tells me that in 1909 he spent three or four months in Santa Rosa as sales manager for EDWARD LAW who headed a company which had a contract to market BURBANK's products. When BURBANK repudiated the contract and the company was dissolved, he remained as sales manager for BURBANK until that contract also was repudiated. A florist by profession, CLARKE reflects the prevailing opinion of the florists of his time. He says: "From the first I did not have a

[3] WILBUR HALL.
[4] Personal conversation, 1937.

very exalted opinion of BURBANK as a plant breeder. He was erratic in his actions and slip-shod in his methods. He was a strange combination of childlike simplicity and Yankee shrewdness. Loving publicity and craving recognition, he was very susceptible to flattery and already in 1909 had begun to believe all the favorable things that were said about him. An example will illustrate his erratic behavior: The busy season was at its height, and BURBANK was fuming because of interruptions in his work — visitors, correspondence, office duties. He finally walked out on them all, leaving the impression that he was engaged upon one of the most important tasks of his life, so they let him go without protest. But I, as sales manager, simply had to see him regardless, therefore, followed him across the street to his other place and found him there, hidden behind the house planting a row of sweet peas, a job so trivial that any boy could have done it because they were not being planted as an experiment but for ornamental purposes. I felt hoaxed and did not recover from the shock for some time.

"I did not take much stock in his claims of being able to judge the value of an ornamental before it flowered or a tree before it was old enough to fruit. Believing this, might account for his habit of selling things before they were adequately tested. He did however, have a discerning eye for racial and varietal characteristics and could, probably, in many instances, pick out and correctly name the right staminate parents of his seedling hybrids. He really was good at this."

I set a high value on the evidence of Dr. GEORGE H. SHULL who spent approximately five years (1906-1911) with BURBANK as the representative of the Carnegie Institution of Washington. This was perhaps the most trying period of BURBANK's life as he was the recipient of a subvention ($10,000 a year) from the Foundation and felt that he must make good, but he found the necessary changes in his working habits to be vexatious in the extreme. However, he coöperated to the best of his ability which is saying a good deal for a man who had always worked alone and was proud of his independence.

"As to Mr. BURBANK's personal habits," writes SHULL,[5] "I would like to say that he was certainly not naturally inclined to profanity. . . . It is my impression from an exceptionally long relationship that he was a man of the finest, cleanest character of any person I have ever known. I always felt that he was the sort of man who *deserved* to be a popular hero. He was not a man to cater to any sort of temporary social blandishment. He was an individualist from start to finish. Meeting people was one of the most distasteful processes which he ever had to endure." He then related how BURBANK was once inveigled into riding in a carriage with a woman in a local rose carnival. "He went through with it, but in expressing his feelings afterwards he gave the most convincing proof that the performance had disgusted him to the point of nausea."

[5] Personal letter to the author, November 25, 1939.

As a young man he must have been even-tempered, mild-mannered, and anxious to please, but as he grew older and was weighted down with cares he became peevish and eccentric. He called himself an "old growler", meaning that he was given to grumbling. Some of his grumbling was pose because he loved to act a part. But it was also a foible. There is no doubt that he fussed over little things and at such times indulged in make-believe faultfinding. It was hard to tell when he was really peevish or merely whimsical. This was particularly true of people not acquainted with him, but he was given to peevish outbursts, gave voice to both real and imaginary grievances. Throughout life he appears to have been addicted to making extravagant statements. One of his biographers[6] who knew him rather intimately says that "numbers meant little to him, that he liked to roll large figures on his tongue." This, coupled with his natural self-esteem, plus his tendency to dramatize a situation, will explain some of the big and little incidents of his life.

It is not generally known that BURBANK was twice married. His first venture occurred when he was a little past forty, a highly susceptible age for a man. On one of his transcontinental trips he met on the train a youngish widow by the name of HELEN A. COLEMAN. She appears to have been favorably impressed with him and he, in college boy parlance, "fell for her hard." She quickly followed him to Santa Rosa and remained there until they became formally engaged. BURBANK purchased a horse and a fashionable carriage (technically known as a phaeton) and entertained her royally for about two weeks when they went to Denver, Colorado, her home, where they were married on September 23, 1890.

Report[7] has it that HELEN was "queer" from the beginning, and many thought she was off-balance, mentally. She was peculiar in her dress and speech and even at home her manner was silly, simpering, and affected. She had the reputation of being an adventuress, but BURBANK was crazy about her. From the beginning she was jealous of BURBANK's mother who lived with him and was then nearly 90 and had been living with LUTHER for over 20 years. HELEN declared that she (his mother) "was a vile serpent, an old vicious cat, and that LUTHER and all his relations were a nest of cats and snakes and low-lived dogs." What she was trying to accomplish was to get rid of all his relatives — mother, sister, a brother or two, and perhaps others. She became a termagant—a confirmed scold.

BURBANK loved children and liked to play with them in his yard while HELEN detested them. She humiliated BURBANK by upbraiding him and ordering the children away in tones loud enough to be heard by the neighbors. She nagged during the day and quarreled at night. The climax approached when she slammed

---

[6] HALL, WILBUR, Harvest of the years. Houghton Mifflin Company, Boston, Mass., 1926.

[7] Personal conversations with persons who knew her.

a screen door on him one day and blacked his eye and a little later jumped up in the night and threatened to shoot him.

He then took up his abode in a room over the garage — a work-room, afterward called the studio — where he could lock himself in at nights and have some degree of peace. This arrangement continued for two years. All the while he was carrying a heavy load of work in addition to the burden of his domestic infelicity, for this was the period when he first began to really attract world attention by his attainments. Under the double load his health failed and he almost became a nervous wreck. He finally sued for divorce which was granted October 19, 1896. HELEN's lawyer made no attempt to answer BURBANK's charge of inhuman cruelty and incompatibility. With characteristic generosity BURBANK voluntarily made her a liberal property settlement.[8] She returned to Denver and thus passed out of his life.

BURBANK's second matrimonial venture occurred on December 21, 1916, when he married his secretary, Miss ELIZABETH WATERS. Although he was 67 and she in her middle twenties this marriage, to the end of his life, appears to have been a peaceful one. The second Mrs. BURBANK, a quiet, well-preserved, young-looking woman, still lives in the BURBANK home.

From what old Santa Rosans tell me BURBANK never cared to cultivate the social graces. Mrs. OLSON,[9] a contemporary of BURBANK, when well past ninety, said of him that he was always awkward and ill at ease at social affairs; that his mind at all times was centered on his work, and not wanting to talk shop, he had nothing to say, so was always fidgety when in company away from home; and that he led a very abnormal existence when a young man in that he never had any women friends.

Mrs. OLSON was several years older than BURBANK and knew him for fifty years. Two of her daughters, Miss PAULINE and Mrs. E. C. MERRITT, did clerical and secretarial work for him off and on from 1900 to 1912. They describe him as being, ordinarily, a shy, diffident man but highly egotistical; that he never would admit he was wrong about anything; that he was careless, sloppy, and unsystematic in his business affairs — in fact, a poor routine business man. Still, he was shrewd, sincere and fundamentally likeable for his many fine qualities and they admired him, though they regretted he was easily imposed upon by designing persons, especially women.

I have talked with several persons who worked for BURBANK at different periods from 1887 to 1926. One of the earliest of these was Dr. D. B. ANDERSON, who still practices dentistry in Santa Rosa, and who did secretarial and accounting work of evenings at BURBANK's home. This was from 1887 to 1889. He found BURBANK to be affable and kind, modest and retiring in some ways but extremely egotistical in others. He was given to periods of

[8] LUTHER BURBANK *vs.* HELEN C. BURBANK, Case No. 4265, Court House, Sonoma County, California, 1896.

[9] Personal conversation.

FEBRUARY, 1892.

New * Gladioli

LITTLE GEM CALLA.

Clematis, Shade Trees, Japan Walnuts, Bulbs, Etc., Etc.

LUTHER BURBANK,

SANTA ROSA, - CALIFORNIA.

BURBANK'S EXPERIMENTAL GROUNDS,

Office: 204 Santa Rosa Avenue. Branch at Sebastopol.

☞ **Special Express Rates.**—It is always better to have trees and plants shipped by express, unless the amount of stock ordered is large. The Wells, Fargo Express Company carry my trees and plants on all their lines at *special low rates;* by this reduction packages weighing less than one hundred pounds are generally delivered anywhere in the United States, and often in foreign countries, for less than by freight, besides always going more safely and speedily.

All Goods are Carefully Packed by experienced men, for which a charge only sufficient to cover cost of material and labor is made, and delivered in good condition to the forwarders, after which my responsibility ceases.

Terms Cash.—*No goods will be shipped unless cash or satisfactory security accompanies the order.*

Remittances may be made by bank drafts on San Francisco, post-office orders, express or registered letters.

TEXTFIGURE 2.—COVER OF AN 1892 CATALOGUE.—BURBANK successfully crossed the Crozy type canna with the wild swamp canna of Florida, *Canna flaccida,* to produce the so-called orchid canna. The Burbank and Tarrytown varieties were popular for many years.

self-exaltation. For example, he once compared himself to NAPOLEON by saying: "See, I am about the same height as NAPOLEON and my hat is about the same size as his, although my head is growing and increasing in size all the time," an intimation that his increasing mental development was making his head expand although he was then about 40 years of age, and it would have been remarkable indeed if his head really were still growing. This might have been a BURBANK whimsey, an act put on to impress young ANDERSON, but the latter does not think so.

This was at the time when he was highly successful as a nurseryman, with a net income of $10,000 or better. His gross sales in 1897 were above $16,000. He certainly had a right to feel proud of his success as a business man. But it was not pride of money coming in that exalted him but the far greater satisfaction of having demonstrated to the members of his family that he was a man in his own right, a man of ability, for in all his earlier years in Massachusetts he was thwarted and discouraged by these same people when he showed a tendency to strike out along new lines. In fact, he makes it clear in his writings of later years that the principal reason for going to California was to get away from these discouraging influences and start life anew where he would have complete freedom of action. Also he was disgusted with the warfare of the churches in New England against DARWIN's books and he wanted to be away from it.

A minor influence was a love affair. Writing about this fifty years later he says, or is made to say:[10] "The story of this early romance of mine has crept into the newspapers now and again; the truth is that I was deeply fond of a beautiful young lady who, as I remember, was less ardent than I was. . . . I determined that my heart was broken. To be frank, I think I gave that affair to many as my reason for coming West . . . . it was the proximate cause, probably the turning point. . . . I find on looking back that there was another motive behind my decision. . . . I was undoubtedly influenced by a desire to be my own man, unadvised by family or friends and no longer compelled to apologize or explain my choice of work. . . ." It is probable that MARY, for that was the young lady's name, being of conservative New England stock, considered young BURBANK to be a dreamer and that he could never make a living for a wife.[11] Others thought so too but not LUTHER. He seems always to have had an abundance of confidence in himself

---

[10] HALL, WILBUR, Harvest of the years, 1926.

[11] I obtained many side lights on BURBANK from Mr. W. I. BEESON of Healdsburg, California. Mr. BEESON married EMMA BURBANK, LUTHER's sister, and they lived together for forty years. During most of this time she was her brother's devoted helper and adviser. Concerning the girl BURBANK was said to have been in love with in Massachusetts, Mr. BEESON has this to say: "The name of the girl was Miss MAY (MARY) CUSHING and I know for a fact that they were only neighborhood friends. He may have admired her and she may not have encouraged him, but that was all there was to it. He never asked her to marry him so she had no opportunity to reject him. Miss CUSHING married a man named W. S. BARTLETT in Massachusetts. She talked this matter over with us when she visited in California in 1936 or 1937. She is now a widow."

and it is understandable that with the coming of material success he felt the urge on occasion to strut or brag; but he had another urge aside from making money and that was to experiment with plants with a view to their improvement. He had to prove to MARY and the members of his family that he could carry on a business enterprise successfully — something they could understand.

Of this period BURBANK is quoted as saying:[12] "CHARLES DARWIN'S *Cross- and Self-Fertilization in the Vegetable Kingdom* was published in 1877 and it was not long before I had a copy. I had spent my first months in California studying the country, comparing various localities as to suitability for my purposes, earning my way with whatever came along to be done and experimenting with plant development. I soon knew most of the native plants and herbs that came under my notice. . . . One sentence in the very introductory chapter of that volume opened the door of my mind and took possession of my fancy. After discussing briefly the marvel of cross-fertilization in plants DARWIN said: 'As plants are adapted by such diversified and effective means for cross-fertilization, it might have been inferred from this fact alone that they derived some great advantage from the process; and it is the object of the present work to show the nature and importance of the benefits to be derived.' Advantages and benefits! DARWIN was writing of the plants themselves — I was thinking of mankind. If Nature had developed an incredible system by which plants could re-create and diversify and improve themselves *for their own benefit* and advantage, why should not Nature be induced to employ that same system *for the benefit and advantage of man?* It was my starting point. . . . DARWIN had experimented with pollenization, but only for the purpose of discovering and setting down laws. He made important and absolutely new findings, but when he had made them and set them down he left it to others to make the rules useful."

Now he was determined to follow his own private star of destiny into this other field of his ambition. The chief food for this urge was his own curiosity and belief that he could accomplish things not yet discovered — his imagination having been fired by reading DARWIN'S books — but there must have been still some other stimulus. It appears from some of his writings that his mother always had confidence in him and doubtless encouraged him to follow his bent, not only because it would make him happy but because she believed in him. And it is highly probable that he also cherished the ambition to confound the scoffers of his youth who had frowned upon his efforts in plant improvement as something that he had best leave alone.

BURBANK was of New England stock but not of the extreme Yankee type like CALVIN COOLIDGE. For example, he was not taciturn and had no nasal twang. The COOLIDGES were proud of the fact that none of them ever went west while the BURBANKS, most

[12] *Ibid.*

of them, migrated to the far west and were not ashamed of it. COOLIDGE, to be sure, was born in the Green Mountains of Vermont but spent most of his life near Northampton, Massachusetts, perhaps 20 miles from Lancaster, Worcester County, which was BURBANK's birthplace and near where he grew to manhood. Being the 13th child in a family of 15 in a middle-class household, where money was none too plentiful, BURBANK absorbed qualities of thrift, industry, and self reliance. His love of horticulture he seems to have inherited from his mother, SAMUEL W. BURBANK's third wife.

Contradictory stories galore have been published about BURBANK's disposition. Some visitors have pictured him as gentle, kind, even angelic; others that he was grumpy, brusque, tactless. Conflicting reports have made the public curious. I have conducted surveys in which I contacted hundreds of people, high and low, to obtain their views of the man. Some had visited him in Santa Rosa while others had formed their opinions from reading or from something said by friends who had met him. These views which have been extensively published or passed along by word of mouth fall into three categories: that he was affable, peevish, or downright rude.

After obtaining the details of a goodly number of cases, I believe I can understand how such a diversity of views or impressions came into existence. BURBANK's every instinct was to secure as much favorable publicity as possible. He particularly craved the approbation of known scientists and representatives of scientific institutions. To him it was all one — whether they came out of curiosity or to study his accomplishments. He chose to believe that they came, one and all, because they approved of him. Never too busy to give time to the notables of the land he welcomed visits from princes, Maharajahs, and captains of industry because publicity came in their wake. To all of these he was the perfect host and was affability itself.

Then there was the rest of the world that came by the hundreds and thousands. Most of these were admirers and came for self-gratification and a bit of reflected glory like shaking hands with the President or with royalty. There were in the aggregate comparatively large numbers of teachers, students, farmers, fruit growers, nurserymen, and the small fry from colleges and other institutions, all with more or less technical knowledge of plant culture. These were the people that seemed to irritate BURBANK. They frequently insisted on cross-questioning him or trying to tell him something when he wanted to do the telling himself. Some of these undoubtedly wanted to criticize or find fault, to get something on him. But the greater majority were well-wishers and many of them potential customers for his wares. There was scarcely a nurseryman or seedsman who did not like to list a BURBANK product as a leader in his catalog.

And, too, there is always a sprinkling of honest people throughout the country, who have accomplished something on a small scale

themselves in the way of originating a new fruit or flower, and naturally want to sit at the master's feet and tell him about it, sometimes for their own aggrandizement and sometimes merely to demonstrate to BURBANK how much they understand him and appreciate what he is doing. But unfortunately, BURBANK is too busy to see them and the visitors are prone to think they are being ignored and, depending upon temperament and past relations with BURBANK, to put the worst possible construction on his motives. Some will fight back when they feel they have been slighted.

In the summer of 1906, at his busiest time and when he was reaching new heights of fame — or notoriety, according to viewpoint — BURBANK had a temperamental visitor by the name of O'MARA, representative of a New York seed and floral establishment, whose pride was hurt because he was not received. He went home and published a highly ironic account of BURBANK's achievements,[13] based mostly on the magazine articles of HARWOOD[14] and WICKSON.[15]

Much of what these writers related was the truth but the fantastic manner in which it was served to the reader led many scientists to believe that he was not to be taken seriously. On the other hand, the masses — the great uninformed public — were profoundly impressed by the beauties and wonders portrayed by both HARWOOD and WICKSON, and to them BURBANK became a marvel of Brobdingnagian proportions and a wizard of the first order. This view has prevailed to the present day and promises to survive because it is being taught to the young. For example, Arbor Day in California, March 7, is LUTHER BURBANK's birthday. This is no coincidence as the date was fixed by the State Legislature many years ago to honor an outstanding citizen, in the same spirit that AUDUBON, JOHN MUIR and JOAQUIN MILLER have been honored.

Each state may have its own heroes. State Departments of Education observe Arbor Day by arranging that appropriate exercises be held in all the elementary schools on a certain day in the spring. The primary purpose is the promotion of tree planting — practical forestry — but the California State Department of Education went much farther by publishing a brochure[16] which was designed to idealize BURBANK. This is in general use all over the United States by teachers of elementary science. BURBANK's impeccable moral character; his known love of children; his cham-

[13] O'MARA, PATRICK, LUTHER BURBANK. A short review of his work in plant hybridization and brief comparison with other hybridizers. Florists Exchange, New York, October 20, 1906. Reprinted in pamphlet form under the same title, by the author in Jersey City, N. Y., September 12, 1907.

[14] HARWOOD, W. S., A maker of new plants and fruits. Scribners Magazine, July, 1904. — LUTHER BURBANK's achievements. Country Calendar, Harrisburg, Pa., 1, 3: 244, July, 1905. — A wonder worker of science. Century Magazine, New York, 69: 656, 1905.

[15] WICKSON, E. J., LUTHER BURBANK, the man, his methods and achievements. Sunset, San Francisco, California, December, 1901; February, 1902; April, 1902; June, 1902.

[16] Conservation, Bird and Arbor Day. California State Board of Education, Sacramento, California, Bulletin No. 19, 1917.

pionship of temperance and clean living; all of this, combined with his life-time efforts at plant improvement, make him an ideal subject for interesting children in citizenship, tireless industry, and love of nature.

Neither O'MARA nor his successors made much progress in stemming this flood of sentiment but O'MARA did meet with considerable success in alienating the views of influential people who are usually committed to the practice of correct thinking; and he did it not so much by logic, as by ridiculing the statements of HARWOOD and WICKSON and letting it go at that as though there was nothing favorable that could be said about BURBANK. HARWOOD, it should be explained, was a professional writer of books and magazine articles and was proud of his ability to popularize science by dramatizing it. In his book *The New Earth. A Recital of the Triumphs of Modern Agriculture,*[17] he relates many facts about that industry, certainly, but, following his journalistic instinct, he dresses up his facts in gaudy raiment. By indulging in hyperbole and by stressing the marvelous, he leaves the uninformed reader with an exaggerated if not wholly incorrect idea of the realities of the noble calling of agriculture.

He followed this same formula in recounting BURBANK's accomplishments, by giving the public what he thought it wanted to hear. The sentimental and uninformed accepted everything he told them as facts. There was much truth in his statements, to be sure, but they were distorted. Thinking people were amazed and didn't know what to believe. The informed reacted in different ways. Some merely smiled and consoled themselves with the thought that it was all too ridiculous to worry about, that people would know how to discount such obvious overstatements; while others grumbled, and a few made half-hearted protest but were shouted down — that is, all except O'MARA.

WICKSON, too, did some injury to BURBANK's reputation among scientists because more was expected of him than from HARWOOD on account of his position as Professor of Horticulture in the University of California. As a state official he spoke with considerable authority and they thought he should have been more conservative in his statements. Agricultural officials everywhere had seen loudly-heralded new varieties of fruits, flowers, and vegetables rise and disappear, and they were slow to believe that so many new things WICKSON gave BURBANK credit for could appear in so short a time and be worthy of planting for income purposes. He was much too enthusiastic about them — seemed to endorse the producer's claims *in toto* — and when some of them failed to make good outside of California, they blamed him for his lack of caution, one of the dearest attributes of the scientist.

However, even WICKSON's colleagues in other states did not know or did not realize that he was also a newspaper man. He led a sort of dual life. In addition to his professorial duties he was

[17] Macmillan Company, New York, 1906.

for forty years the editor of the *Pacific Rural Press*, perhaps the most influential horticultural journal on the Pacific Coast. The statements made by Editor WICKSON in his newspaper and, more important still, in his magazine articles were not necessarily couched in the same words that Professor WICKSON used in writing his widely used horticultural books. I mean that his newspaper writings were enlivened by a puckish wit that sometimes caused him to be misunderstood. In writing or in public speech he was witty without effort. He loved to poke fun at people and things. While he grew lyrical in some of his articles about BURBANK he was slyly satirical in others. Also as editor of a farm publication he dared not let his thoughts soar in this technical journal as he would in a magazine. The one was personal, the other impersonal. In presenting a thought to his farm patrons he had to keep his feet on the earth. Time and again subscribers would ask about this or that BURBANK product: was a certain fruit all that was claimed for it by BURBANK or by the nurseryman who had purchased the right to its distribution? And would the Editor advise him to plant it?

BURBANK's establishment was not far away; they were good personal friends; he had written glowingly, but in general terms, about BURBANK's accomplishments; he didn't want to offend. But now it was necessary to speak in specific terms; so he sometimes hedged by speaking in parables; or, in mock serious vein, managed to let the wise reader know that the fruit inquired about appeared to be promising but had not been adequately tested and the reader had better practice conservatism until more information had been accumulated. Many years later he even spoke out plainly when certain things were known to have turned out badly. WICKSON was honest but his outlook was that of the publicist rather than that of the scientist. His faults might be likened to what is known as poetical license. He strove to be entertaining and was, regardless. . . .

A state or national convention in San Francisco was never complete unless the delegates could spend a day in Santa Rosa seeing the BURBANK gardens. Travel bureaus and chambers of commerce encouraged this. Don't forget for a minute that BURBANK loved this public acclaim but it must be remembered at the same time that he was a conscientious worker and earnestly engaged in a cause that he honestly believed was contributing to the happiness, well-being, and prosperity of the world.

Now let us imagine it is the month of July, about the year 1910 or 1911, both busy years as attested by his having issued during each at least eight catalog announcements. For the experimental horticulturist, July is the busiest single month of the year — it is also the month of conventions — because most kinds of fruits are ripening and observations have to be made and recorded, and flower seeds are maturing and must be harvested, dried, and stored. Remember, too, that BURBANK was a one-man institution and rightly or wrongly he rarely or never entrusted to others the task

of making observations and passing judgment on his hundreds or thousands of hybrids undergoing test.

He rises at daybreak, about 4:30, and at 5 o'clock he is at work in his Sebastopol trial orchard seven miles away. Every minute counts. Scores of fruits are ripening, for they are all seedlings and no two alike — there are apples, peaches, pears, plums, grapes, and on this day perhaps a few late cherries; and all must be observed for size, shape, color, and *taste*: and the sun is hot and he is past sixty years of age. By noon he is thoroughly tired and returns home with a sour stomach from sampling too many acid fruits, and finds several visitors waiting to see him. Passing from the garage to the house he runs the gauntlet of outstretched hands and cheery greetings. He bows right and left and impatiently tells the callers he regrets that he cannot stop to talk with them. At the door a man waylays him and grabs his hand only to be thrust aside. Another more daring than the rest follows him into his study and insists upon introducing himself and explaining why he should have an interview. He is asked to leave.

After BURBANK finally sits down to lunch the telephone announces that a party of seventy-five or a hundred persons have arrived in town and wish to be conducted over his gardens. The local Chamber of Commerce secretary protests that the party was sent over by a travel bureau, a plan BURBANK had approved months earlier, and what should he do with them. BURBANK capitulates and the party comes, but he is not a gracious host. Some were grateful for having seen him under any circumstances; others considered him to be peevish; while the few that had forced their attentions upon him and were repulsed said he was rude.

At this point, I ask the reader what he would have done had he been in BURBANK's place. There are two plausible replies. One, that he should have engaged an assistant and trained him to help with the field work; and two, he should have hired a public contact man. Unfortunately, neither of these was possible or practicable for BURBANK. He would not trust anyone to make the selections from his numerous hybrids and the people did not want to see a public contact man or any other man but BURBANK. The great majority of visitors came through curiosity and they much preferred to see the man rather than his productions if they could not do both. As a matter of fact, announcement was made April 30, 1910, that a bureau of information had been established with Miss PAULINE OLSON in charge. Miss OLSON was his secretary. Nothing much came of this plan except that there was now someone to answer questions and casual visitors were not summarily sent packing. They might even feast their eyes on the mighty BURBANK at a distance as he worked in his garden. But this did not suit a lot of people, particularly the self-important, for these, alas, also had an ego to be fed. And in truth, it did not suit BUBBANK either. Although shy in a way and perhaps fundamentally modest he responded to adulation and even hungered for it and therefore could not long deprive himself of this kind of food.

For more than 30 years BURBANK was a world character. Perhaps the name of no king or potentate was so well known; and now (1944), 18 years after his death, the name still lives, and it promises to survive for another generation at least because countless thousands of people now living were taught to revere the name. Doubtless no character in our history, GEORGE WASHINGTON not excepted, has had so many fairy tales spun about his life and accomplishments.

His admirers have pictured him as a wizard, a magician, or a demigod. His detractors, on the other hand, have not hesitated to rate him as a charlatan and a fraud. Very rarely has there been anything like a half-way position, and these widely divergent opinions still exist. For years, I have amused myself by bringing up the question from time to time among acquaintances just to obtain their reactions to the name. In a broad general way, BURBANK all along has been extravagantly praised by ministers, grade school teachers, garden lovers, space writers of the sentimental or sob sister variety, and by those who were selling his wares. He was condemned by rival nurserymen and by some who called themselves scientists. In all fairness, I should add, however, that I have rarely known or heard of an instructor in a biological science who taught his students that BURBANK was a fraud. These instructors were apt to evade the question or to abandon the subject as quickly as possible. The effect was to condemn the man with slight praise. Editors were sometimes on one side of the fence and sometimes on the other, depending upon their bias or some little bit of information or misinformation which might have come their way.

It must be remembered that the world at large secured most of its information from the Sunday supplements and from advertising literature. Space writers universally accepted everything and did not try to ascertain the facts, if indeed they were capable of passing judgment on the merits or demerits of this or that fruit or flower, which I very much doubt. The advertisers — dealers who had purchased BURBANK products — for obvious reasons were usually over-enthusiastic and prone to follow the good old policy of *caveat emptor* — let the buyer beware!

Those who were close to BURBANK in his daily life credit him with possessing a considerable sense of humor, even at his own expense, providing the shafts were not directed at him — obliquely. He couldn't bear ridicule, even in fun. The old gag about his having crossed the milkweed with the eggplant to produce an omelette, his biographer[18] says, "left him cold" because of the implication. However, he did enjoy the ludicrous if it did not reflect on his work, as illustrated by an incident that occurred about 1900. He was opening and reading his mail one morning when he suddenly threw back his head and roared with laughter. He finally explained to his secretary, Mrs. MERRITT — or maybe she then was

[18] WILBUR HALL.

still Miss OLSON — that the letter was from a man in Denver who said he had some time before married HELEN, BURBANK's former wife, but regretted the step and was anxious to be rid of her and asked BURBANK's advice about how to proceed. This so appealed to BURBANK's sense of humor that he doubled up and laughed till the tears ran down his cheeks. He thought it was the funniest thing he had ever heard in his life.

BURBANK was a man of generous impulses and ever ready to contribute time and money for the good of the community. Time and again he left his work to lend his presence to the opening of a convention in San Francisco or elsewhere, or to sit in councils held for the betterment of his home town. On one occasion he traveled with a party of men to British Columbia to promote the Panama-Pacific International Exposition which was to be held in San Francisco in 1915. He doubtless felt doubly repaid for this trip as he was signally honored at every stop. In Victoria he just about stole the show. He was accorded great honors, "the Canadian Minister of Agriculture came all the way from Ottawa to greet him."[19]

He presented the schools of Santa Rosa with phonographs and moving picture projectors saying, "The emotions should be cultivated as well as the intellect."[20] He also donated $5,000 in cash for the development of a park that had been given to the city by his fellow-townsman, FRANK DOYLE, for a children's playground.[21]

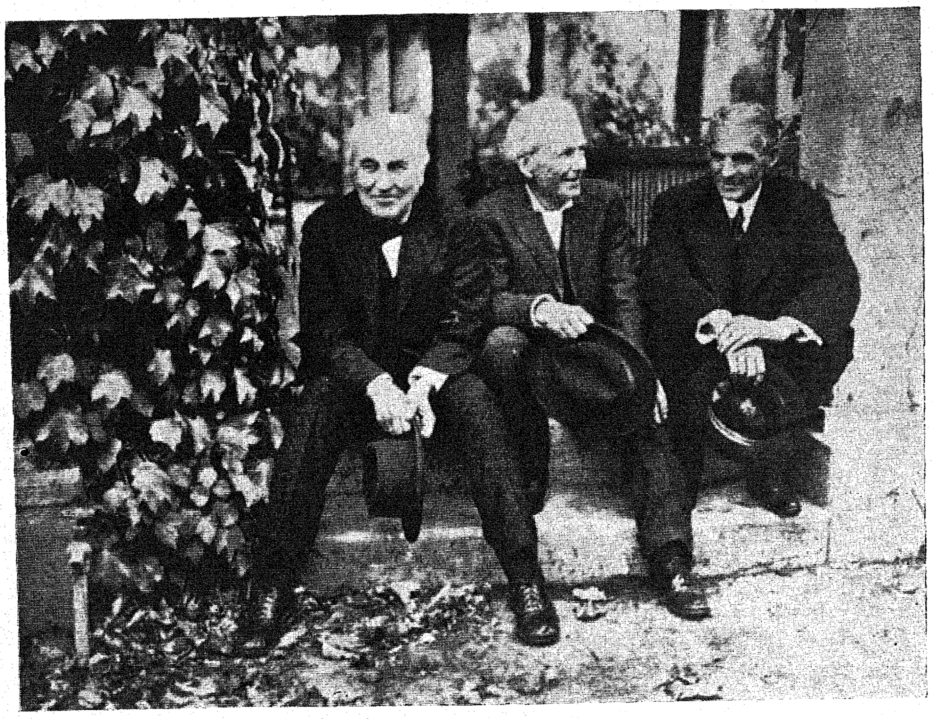
I think that BURBANK's lifetime secret — the only skeleton in his family closet — was the same that troubles so many self-made men, namely, that he felt he was inadequate, had somehow missed something because of his lack of formal education. While one part of his brain hinted at inferiority, another part both denied the thought and at the same time urged that it be suppressed. But a haunting thought is difficult to subdue. He wanted to believe all of the nice things said about him — much of it cheap flattery — but in passing judgment upon himself his native honesty and common sense decreed that he apply the measuring stick he so often advised when evaluating his novelties, "look to their

[19] Santa Rosa Press-Democrat, September 3, 1912.

[20] Santa Rosa Press-Democrat, February 27, 1913.

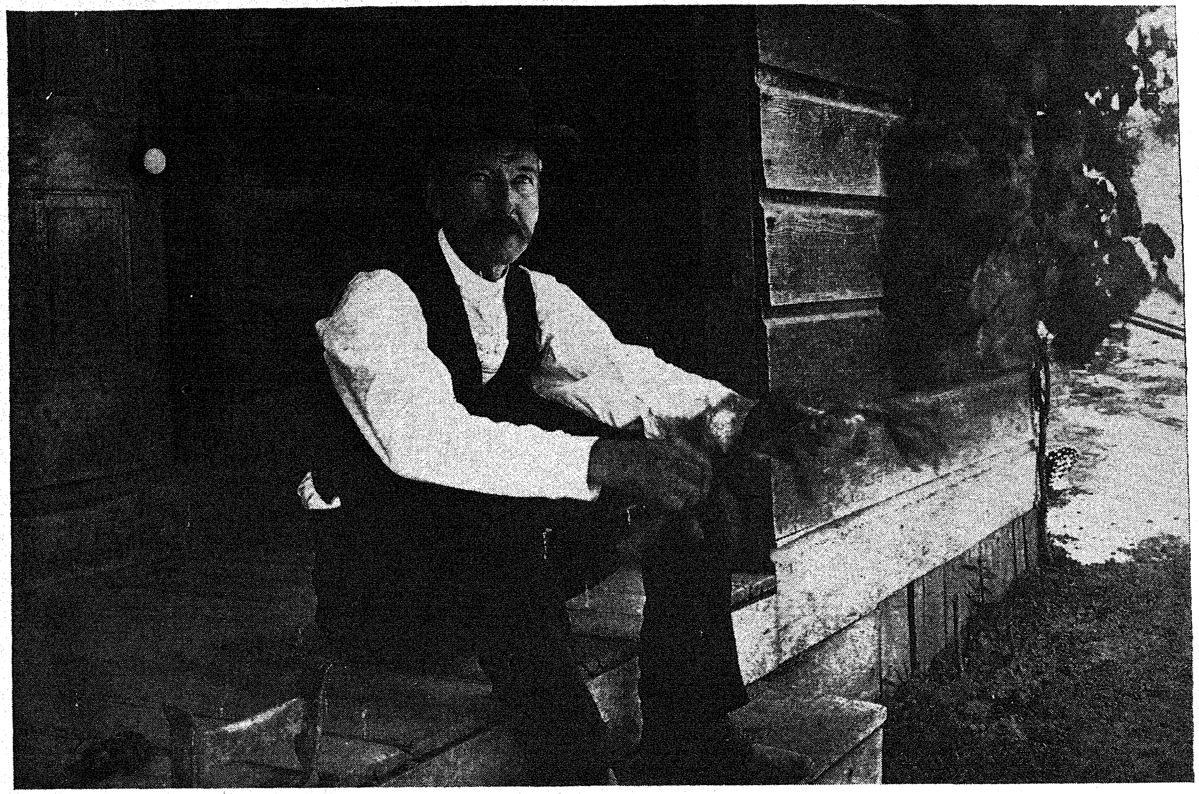
[21] In a personal interview with the author, Mr. DOYLE said: "Three days after the local papers announced that I had deeded a tract of land to the city for a public park, primarily as a playground for children, BURBANK walked into my office and asked if the published statements were true, and when I told him they were, he wanted to know if it was not also true that the land, although covered with wide-spreading oaks, needed extensive improvements before it could be used as a playground and that the city had no money that could be used for that purpose. Upon admitting the correctness of his surmises, he remarked, 'I thought so' and without another word handed me his personal check for $5,000 and requested that I see to it that the land was put in proper shape."

It is highly probable that BURBANK had a sentimental interest in the tract aside from his desire to see the needs of the children taken care of, as there is an old story to the effect that when a young man, and new to Santa Rosa and to California, he did not attend church because he thought his clothes were too shabby, but instead, spent many a Sunday communing with Nature under the trees of what is now Doyle Park. It was fitting, too, that memorial services were held there following his death in 1926.



THOMAS A. EDISON, LUTHER BURBANK and HENRY FORD. — EDISON and FORD visited BURBANK during the San Francisco Exposition in 1915. This picture appears on the back cover of BURBANK's catalogue, "Twentieth Century Fruits, 1916-1917."

(*Courtesy of* Stark Brothers Nurseries and Orchards Company.)



LUTHER BURBANK at the work house on his experimental grounds (Sebastopol or Gold Ridge Farm), near Sebastopol, California, about seven miles from Santa Rosa. — PHOTOGRAPH made by Professor L. H. BAILEY in 1901 when BURBANK was fifty-two years old. BURBANK said it made him look like a Cheshire cat. (*Courtesy of* Dr. J. ELIOT COIT.)

source." (If they originated with BURBANK, they were genuine and worthy; if not, beware!) He knew that much of the fulsome praise with which he was deluged was hollow because those who dispensed it were incompetent to pass judgment — that is, ignorant of the subject — or had special reasons for their exuberant boosting.

His position, then, was something like that of one of the ancient martyrs in reverse, if the simile is not too fantastic. When the martyr felt that he was possessed of a devil (temptation, perhaps), he exorcised the demon by prayer, penance or flagellation. But BURBANK was beset with kindly furies and one does not punish the flesh on account of pleasant thoughts, if they are not sinful. So he followed the easy way, by doing nothing.

The conflict of emotions must have continued throughout most of his life — wanting to believe something but not quite daring. He knew he was a good working scientist but he also knew that he was illy-equipped to qualify as a conventional scientist. Finally, BURBANK's was not the complex character that some have supposed. On the contrary he was rather simple — simple and honest — even naïve. He applied himself to his task with a devotion and a single-mindedness of purpose that only the zealot can attain. His task was his religion, for he believed that he had a mission to perform and that one life-span was not enough time for its fulfillment. He must concentrate and he must hurry. This was why he was so impatient at interruption. There was no time to think up schemes for defrauding his fellow-man, even if inclined that way — which he was not. Being devoid of evil himself, he did not suspect evil in others when approached with grandiose schemes. He was forced to market his productions and when he set his mind to it could be a shrewd bargainer, but he never liked merchandizing. Hence he fell a ready victim when approached by promoters who offered to take over the marketing of his entire output of productions at what seemed to be remunerative figures.

One time, after tying himself up, he arbitrarily broke the bonds and was magnanimously released from his contract when it was still too early to know whether the plan was either workable or profitable. The next time, he was not so fortunate. The monetary rewards offered seemed greater and the terms less onerous than before and he went through with it to his everlasting regret because in the end he not only suffered money losses but much personal humiliation as well.

He thought they (the people he sold to) could and would pay him as they could make a good thing out of the products he was selling them, for he had plenty of confidence in these products. How they were to reap these profits was no concern of his. No doubt he assumed they would multiply the plants, seeds, etc. as rapidly as possible and then put on a selling campaign, with all the advertising artistry he had become accustomed to seeing employed by firms that had purchased individual fruits, etc. from

him in the past — especially during the last ten years since he had issued his famous catalog of *New Creations* in 1893. However, his knowledge of the nursery business must have made him aware of the fact that no considerable legitimate profits could derive to the company in the immediate future as it would require at least two years to multiply the seeds and plants in sufficient quantities to fill the thousands of orders that would come in as a result of the extensive advertising that would surely be employed.

Whether he experienced qualms or not we do not know. According to the ethics of trade he had no reason for being nervous or distraught except possibly as the debtor might naturally worry a bit as to whether the creditor could meet his obligations. Also, business morals did not prescribe that he should concern himself with the doings of his creditors as long as they dealt in lawful commodities, legally acquired; and the stock he sold the company easily met these requirements. After all, the promoters were reputedly persons of ample means, financially able to fulfill the obligations they had entered into; and I am inclined to believe that he accepted them at their own estimate without inquiring too carefully into their representations. Another evidence of this naïveté. (See Chapter VIII).

Yes, fundamentally he was artless, not difficult to understand. He wished to be fair in his bargainings, according to his lights, and not only expected but believed that others would be likewise. I do not think he should be condemned for overpraising his wares when this was the accepted practice among his contemporaries and still is, and — while the practice may be personally distasteful to some — such people continue to be rated as respectable and everywhere accepted in good society. Even dissenters should not concentrate all their opprobrium on a single individual just because he happens to be famous and therefore conspicuous. His personal morals were of the best and his business ethics would stand comparisons with many, if not most, of his competitors.

IV

BURBANK THE NURSERYMAN

LUTHER BURBANK was a born nurseryman if ever there was one. By this is meant that his every instinct, his every reaction, was that of a nurseryman or seedsman, for the two vocations are much alike, and he practiced both. Throughout his career, his ideals and ethics, as well as his showmanship, were ever such as we might associate with a progressive nurseryman. He loved to grow seeds and plants and to propagate and improve them and, finally, to sell them at a profit. From the very beginning of his business life he liked to show his experienced competitors that he could beat them at their own game.

The uninitiated can have little idea how difficult this would be, for the nursery and seed trades are highly competitive; and while many engage in them at one time or another, few remain in business on a national scale. It requires skill in propagation but still greater skill and acumen in determining what to propagate. Both seeds and plants are living things that must be handled with care throughout their growing period and in storage. To be sure, the bulk of the business will consist of staple items (standard varieties), but one year with another these may show little profit. Happy is the nurseryman or seedsman who can make a safe living handling only standard varieties. Yes, you have guessed it — the real profits come from promoting new things and persuading the public to buy them. Good judgment and a certain amount of boldness are necessary in making the selections and great shrewdness needed in merchandising them.

Naturally, it is the aim of every firm to offer something new each year. It is customary to issue a catalog in the autumn announcing the stock that will be ready for delivery the following spring. New varieties are described in extravagant terms. The ethics of the profession permit of this, and therein lies both the strength and the weakness of the nursery and seed business. Where such wide latitude is exercised in making announcements the unscrupulous may grossly misrepresent their offerings, and the more or less innocent purchaser has little protection or recourse as both seeds and plants are sold with broad disclaimers as to trueness to variety and other attributes. But this is not the only hazard to the purchaser. What is even more important, in the case of fruit trees, is that they be fruitful and adapted to the climate where they are to be grown. This is a vital matter to those who plant commercial orchards as it requires from four to six years for them to come into bearing, and only then can it be

known whether the variety is as represented and whether it will bloom so early as to be caught by late spring frosts. The old or standard varieties in existence are with us because they have survived long years of natural and artificial selection, nature having eliminated some of the undesirables and man the rest.

A mistake in planting annual crops such as vegetables, flowers, and grains is not so serious because soon discovered and only one season is lost. Fortunately, the farmer, fruit grower, gardener, or florist who plants on a large scale or deals with expensive crops and equipment is usually an experienced person who appreciates the risk of depending on new and untried things. He must, however, be alert enough to keep up with the times for new and better varieties do occasionally appear. So he must take what is offered, plant in a small experimental way, and observe their behavior. For the most part, he must be conservative and stick to those things which have been thoroughly tested. On the other hand, the amateur who has only a home garden is apt to be attracted by the glowing descriptions and plant the new things exclusively, often to his regret. While the individual suffers little monetary loss even at the high prices paid for novelties, such orders in the aggregate represent enormous sums that we pay annually as a tribute to our enthusiasms and gullibility. Those that plant in a spirit of adventure or as experimentalists no doubt secure their money's worth, but others would do better to stick to tried and proven things.

BURBANK was both shrewd and resourceful. As a boy in Massachusetts he found that he could not successfully compete with established market gardeners in the selling of vegetables unless he could offer a product that was superior in some respect; so he began to hybridize varieties with the idea of producing something that would mature earlier than normal, and actually achieved some success in this directon by offering a type of sweet corn that was a week earlier than usual.

Transferring his activities to California, he drifted by easy stages into the nursery business. At first he worked for a few months for a nurseryman in Petaluma, and about 1877 started a nursery business of his own on his mother's place in Santa Rosa. He entered the nursery business at a time when eastern markets were beckoning to California for its fruits. The transcontinental

---

TEXTFIGURE 3.—COVER OF A LEAFLET, issued by BURBANK in 1892, just previous to the announcement of several of his spectacular fruit hybrids, and he was becoming concerned about his ability to market his productions and still find time to continue with his experimental work. Nothing came of his offer to become a member of a stock company, either because he was not yet famous enough to attract speculators, or, more probably, because he found that he could sell most of his productions outright himself, and thereby retain full control of his business. His temperament was such that he could brook no interference with his affairs by anyone and he thought he had his problem solved by selling each new production "lock, stock, and barrel," for cash, as produced. Twenty years later this policy led to his financial downfall, and indirectly, to heartbreaking losses on the part of many of his trusting friends.

The Time is Now at Hand

WHEN Eastern planters are beginning to realize that all the valuable novelties do not originate in Europe or Eastern America, and those who have not yet grasped that fact may not know that for many years Eastern seedmen, florists and nurserymen have been selling as novelties, trees, plants and seeds which originated on my own Experimental Grounds at Santa Rosa.

These novelties must first be sold in Europe and distributed from there in order to receive sanction and sale in America.

THE TWENTY MILLION

Hybrid and cross-bred seedling plants which I have produced during the past twenty-five years, and the twenty-five thousand dollars, and the endless labor bestowed in hybridizing, selecting, testing, etc., is now being more generally recognized, and some of the fruits and flowers originated by my labors are becoming household words wherever fruits and flowers are admired.

In the fall of 1893 two new Quinces will be introduced: The "Van Deman" and the "Santa Rosa." They are in all respects the greatest advance ever made in improving this fruit. These new varieties are of the most beautiful form, smooth as an apple, rich golden color, and without a trace of the unsightly wooly substance which so much disfigures the Quinces now known.

Van Deman is larger than any known Quince, both are unequaled in size, early bearing, productiveness, beauty of form and color, and the quality of the fruit is such that they are, when ripe, tender and good to eat uncooked like Apples, both cook as quickly as Apples and are delicious whether cooked like the old fashioned Quinces, or baked like Apples.

The six hundred thousand hybrid and cross-bred seedling Berry plants which I am growing, and more than half a million hybrid seedling Lilies are producing profound surprise and admiration, and from the vast chaos of commingled species, forms have been created and segregated which will produce great and unsuspected changes in fruit and flower culture.

When I mention, for instance, a Blackberry x Raspberry hybrid of largest size which ripens before Strawberries, before Raspberries bloom and before other Blackberries show a single leaf or bud, some idea may be formed of some of the tremendous changes which will be produced in berry culture. The *best*, after a most exhaustive and careful trial, will be introduced from time to time.

The above does not even outline the work which is being accomplished on my Experimental Grounds, only having mentioned two or three of many thousand horticultural acquisitions which only a few years ago were thought to be utterly impossible. My time is so wholly occupied in their production that I cannot well attend to their introduction and will sell the stock and complete control of some of the most promising new fruits and plants, or would be a member of a joint stock company, for their introduction.

Correspondence on the subject solicited.

LUTHER BURBANK,
Santa Rosa, Cal.

Though perhaps unnecessary, I may refer as to the extent and value of my horticultural labors to

Prof. H. E. Van Deman, U. S. Pomologist, Washington, D. C.

Prof. T. V. Munson, Dennison, Texas.

Prof. E. J. Wickson, Editor *Pacific Rural Press* and author of "California Fruits," San Francisco, Cal.

railroad had been completed only a few years before, and here and there daring spirits were shipping fruit to far-away Chicago and receiving fancy prices. Of course, little was known about refrigeration or methods of packing for long shipments, but some had successfully pioneered the venture and much interest was aroused in planting orchards and vineyards. The times were favorable for starting a nursery as existing concerns could not keep up with the demands for planting-stock. Especially was this true of prunes because that fruit could be sun-dried and sent to distant places with little danger of injury in transit. This looked like a safe crop and plantings, accordingly, were large.

In the midst of a financial depression and without capital or credit BURBANK necessarily had to start in a small way, budding, grafting, planting, and cultivating all his trees himself with his own hands. Under ordinary practice two seasons are required for producing a young fruit tree ready for orchard planting. The seeds are planted in the spring for the first season, and in late summer of the same season the little seedlings are budded near the ground to the desired variety. The buds unite with their host but remain dormant. The following spring — this is the second season — the trees are cut off just above the transplanted buds and all subsequent growth, consequently, directed into them, and by October, in California, they make trees four to six feet tall. When the leaves fall, they are ready to be dug up and planted in the orchard.

Sometimes excess seedlings are sold to people who want to do their own budding. Although the small nurseryman may be specializing in the production of fruit trees he usually helps out his income by propagating a few grapevines and ornamental shrubs from seeds or cuttings, as all of these reach salable sizes in a single season. BURBANK must have done something of this kind for he tells us[22] that he had an income from his business the first year, 1877, of $15.20. Next year when the first budded trees became marketable, his income rose to $84. The third year, 1879, the sales were $353.28, and the fourth year they mounted to $702. He says: " . . . it was not until 1881 when the nursery had been for five years in operation that the aggregate returns from the sale of its products of all description passed the one thousand dollar mark. The exact figure was $1,112.69."

Then he did a spectacular thing that was truly Burbankian in its shrewdness of conception and boldness of execution. He accepted an order for 20,000 prune trees to be delivered inside of 12 months, and made good to the extent of actually delivering 19,500 trees greatly to the delight of the customer and to the enhancement of his own reputation. This was the first time that he was referred to as a "plant wizard". Although this was a horticultural stunt that had been employed by others, BURBANK de-

[22] LUTHER BURBANK, his methods and discoveries and their practical application. Edited by HENRY SMITH WILLIAMS. The Luther Burbank Press, Santa Rosa, California, 12:82, 1915.

serves full credit for having had the enterprise and initiative to do something that was new to his locality if not to the state. In the southern states the process is known as June budding or force budding, and is widely used in the propagation of peaches. Mr. JOHN FRAZER,[23] a veteran nurseryman of Huntsville, Alabama, thinks the practice originated in what is commonly known as the Huntsville area which includes Northern Alabama, Northern Georgia, and Central Tennessee. He doubtless refers to the commercial use of the practice, as the method must have been known by propagators in warm countries wherever peaches are grown as far back as varieties have been perpetuated by means of budding.

Successful June budding depends upon a long, favorable growing season. The buds must be inserted when the trees are still very small — in fact, as early as it is possible to obtain buds from the current season's growth on bearing trees. When the bud is established beneath the bark of its host, the top of the little tree is partially broken but not detached. This forces the growth into the bud, and, when it begins to push, the top is wholly removed. During the remainder of the season rains must be frequent to make trees of marketable size. In California growth is regulated by irrigation.

There is prejudice against June-budded trees in some sections of the country, and this feeling is kept alive by those who, for climatic reasons, are unable to grow such trees. As a matter of fact, trees that are grown in a single season are equally as good as those grown in two seasons if they are of the same size, but the cost of producing them is less. If the nurseryman who does grow them passes along this saving to the consumer it is easy to see why his northern competitor may exhibit jealousy.

In California, BURBANK was "made" as a nurseryman as a result of his prune tree exploit. He received a vast amount of favorable publicity, even beyond his home state — the kind of publicity that money will not buy. In this respect he emulated his friend HENRY FORD, whom he greatly admired. Like FORD, he was always about two jumps ahead of his competitors. And he was ever thus.

The nursery business thrived and in 1883 he purchased four acres of land across the street from his mother's place. This was then in the center of the town of Santa Rosa. He was now definitely established in his chosen line and began to branch out into the specialized field of plant improvement that he had always had in mind. Of this period he writes:[24]

"At about this time there was an interest in the native plants of California, and many nurserymen were anxious to give them a trial. During those years when my own nursery business was only formative I eked out an income — in intervals of carpenter

---

[23] Personal letter to the author, July 27, 1939.

[24] LUTHER BURBANK, his methods and discoveries and their practical application. Edited by HENRY SMITH WILLIAMS, 12:99, 1915.

work — by gathering seeds and bulbs on orders from various eastern and foreign firms. In the course of this work I made various trips to the surrounding territory. On two occasions, in 1880 and 1881, I visited the region of the geysers, which was found to be a productive locality for new material. And everywhere I went careful study was made of the vegetation, both with an eye to the immediate collection of seeds and bulbs, and for future reference in connection with the projected work.

"Even before I could see my way to the abandonment of the practical work of the nurseryman, projects were in hand that were preparing the way for the new activities. In particular, I had sent to Japan to secure seeds and cuttings of a great variety of fruits. It seemed certain that I could better afford to hire collectors in foreign lands to secure material than to go to foreign lands in person in quest of it.

"The first consignment of Japanese seeds and seedlings reached me November 5, 1884. In preparation for their coming I had purchased the Dimmick place and prepared my experiment grounds a few months earlier. And when the consignment was in hand, with the representatives of exotic species of fruits, I felt that a new era had begun for me, and that the long frustrated plans were about to find realization.

"The following year, so well had the nursery business prospered, I was able to purchase a farm at Sebastopol, seven miles away from Santa Rosa, where the conditions were more favorable for the growing of some types of plants.

"The second consignment from Japan, including the plum, whose story has elsewhere been told in detail, came December 20, 1885. The place at Sebastopol where they were to be planted and nurtured was purchased eight days later. And with this purchase the project of devoting a lifetime to the work of plant experimentation was fairly and finally inaugurated. For the Sebastopol place, with its eighteen acres, was not purchased for use as a practical nursery, but solely as an experiment garden.

"With the development of the Sebastopol place, a new phase of life work began.

"Thenceforward my time was divided between the experiment garden at Santa Rosa and that at Sebastopol, and upon one place or the other all my experiments in plant development were to be performed.

"An interest in the nursery business was retained for two or three years more, to give money to carry out the initial stages of the new experiments; for of course it could not be expected that new varieties of fruits and flowers would spring into existence in a single season. Nor could instant purchasers be found for them if they had been thus magically produced. But from the time when the place at Sebastopol was purchased, the die was cast, and it was determined in future my energies were to be devoted to the work of plant development — the work that had been

projected, and at which a beginning had been made back in Massachusetts, and hope of continuing which had been the incentive to persistent efforts during the period of stress and privation."

The year 1887 marked the appearance of BURBANK's first real nursery catalog — a 24-page brochure[25] offering the usual standard varieties of fruits, but in addition, many new things including the initial announcement of the first of the long line of Japanese plums he was later to introduce, such as the Blood Plum of Satsuma, which he received from Mr. ISAAC BUNTING, an export-import agent in Yokohama, Japan, December 20, 1885. An eight-page supplement[26] followed very shortly the same year. The contents of the catalog showed that he was going in heavily for new things — novelties he called them — and although he did not claim to be the originator of these unusual things, he left that impression, a trick that was not unusual among nurserymen. Several promising seedlings were listed; among these were apples, pears, plums, peaches, figs, persimmons, olives, and oranges. He refers to himself, about this time, as a dealer in novelties. But while most nurserymen were content to let others find new and promising things as chance seedlings, he was importing from Japan things that for the most part were entirely new.

As I peruse the catalog which lies before me, I am amazed at the modest manner in which he announces the new Japanese plums: the Botan, Chabot, Long Fruit, Masu or Large Fruit, Botankio, Botankio No. 2, and especially the Blood Plum of Satsuma, all of which he knew to be brand-new. This was not like him. He had not yet learned to make the fullest use of the printed word. It is true that he did expand slightly in describing the Blood Plum of Satsuma by stating that he had the only tree growing in America and that it had cost him $40 in Japan, but the statement was made in 8-point type! The price quoted was one dollar per tree or seventy-five cents each for dormant buds. The only explanation I can offer is that he did not realize what he had. This mistake was remedied to some extent in the supplement that followed the catalog, but even here his walnuts and chestnuts from Japan were given more publicity space than the plums. As it turned out, the walnuts are merely a curiosity and the chestnut only of minor importance, while the plums laid the foundation of a huge industry, particularly in California and South Africa, and are of considerable importance in many other states and countries.

Because the introduction of the Japanese plums was a distinct achievement and because some doubt has been expressed by

[25] Catalog of fruit and shade trees, ornamental plants and roses, grown and for sale at Santa Rosa Nurseries, LUTHER BURBANK, Proprietor, Santa Rosa, Sonoma County, California.

[26] Special descriptive circular of some new rare and very desirable trees and plants grown for sale by LUTHER BURBANK, Santa Rosa, Sonoma County, California.

LEONARD COATES[21] as to whether BURBANK actually brought them in or obtained them from a San Francisco importer, it will be of interest to cite a bit of background. In the first place, even if COATES did have some basis for his claim, I should not take him too seriously, for they were professional rivals and business competitors. COATES had the reputation of being a man of high and honorable principles but in this case he seems to have been obsessed by envy or jealousy.

Another reason why I believe that BURBANK really imported the Blood Plum of Satsuma was a statement that he makes, which I think is genuine. In one of his catalogs he tells about an occasion, presumably in the early eighties, of browsing in the Mechanics Library in San Francisco when he came upon a book of travels in which an American sailor told of having visited the province of Satsuma in Japan and there saw and ate plums with a deep red flesh. This excited BURBANK's imagination, and he determined to secure some of the trees at the first opportunity. The first shipment he received from his agent in Japan, as stated before, arrived in 1884, but the trees had dried up and died in transit. He immediately re-ordered and the second shipment arrived December 20, 1885. Among BURBANK's effects after his death, I found a memorandum partly in his own handwriting and partly in typewritten form as he tapped it out on his ancient typewriter, a manner of writing that I am very familiar with from having seen many of his letters of the period. This memorandum had apparently been made out at different times for his own information. It began in 1875 and ended in 1910. Under the entry for December 20, 1885, the statement reads:

"New Japanese plums imported (from ISAAC BUNTING, Yokohama)

No. 1 —Blood Plum of Satsuma.
No. 2 —Large red plum, very good. [Later named Burbank.]
No. 3 —[Plum]—green skin, conical shaped, red flesh.

[21]Personal interview with LEONARD COATES, veteran California nurseryman, in the summer of 1932 just before his death. COATES was something of a plant hybridizer himself having originated and introduced a prune, the Coates 1418, that was widely planted in the early twenties but afterwards declined in popularity. COATES stated that J. E. AMOORE, a tea buyer in Japan, came to San Francisco in the eighties and set up a Japanese tree-importing company and thousands of plums were brought in under Japanese names, and he thought it was highly probable the Satsuma was thus introduced. There was some ground for COATES' supposition, for BURBANK did procure some trees from an importer—how many, we do not know—as shown by the following statement by BURBANK, copied from "LUTHER BURBANK, his methods and discoveries and their practical application", Vol. 5, page 36.

"The Satsuma and Burbank were the only two among my 12 seedlings that were directly introduced, although sundry of the others subsequently had a share in the production of hybrid races. It should be recalled also that I had somewhat earlier introduced three plums of Oriental origin—the Abundance, Chabot, and Berkmans, that were also a direct product of Oriental stock grown and fruited by me *from seedlings purchased from other importers.* [Italics mine.] I have not dwelt at length on them here because they seem of relatively less importance in retrospect than they appeared at the time when they were introduced."

No. 4 —Prunus Japonica, large, conical, red, good.
No. 5 —Supposed Korean variety.
No. 6 —Prunus Japonica—preserving variety.
No. 7 —Large white [plum]—Like Washington.
No. 8 —Prunus Japonica—pale yellow or white.
No. 9 —Rose colored, flowered variety, Prunus mume — small.
No. 10—Earliest preserving variety.
No. 11—Prunus mume.
No. 12—Very late bearing variety [plum?]."

The descriptions mentioned were evidently supplied by Mr. BUNTING, the exporter.

The memorandum states that there were 100 specimens of Blood Plum of Satsuma in the shipment and 10 trees of each of the others. This does not square with a statement attributed to BURBANK in Volume 5 of the book *Luther Burbank, His Methods and Discoveries*, etc. in which he is made to say, after recounting the failure of the first shipment to arrive in good shape:

"A little over a year later on December 20, 1885, there arrived the 12 seedlings to which I have already referred. And this time, to my great satisfaction, the tiny trees were found in good condition."

This discrepancy is one of detail rather than one of merit. Just how many trees of a variety were in the shipment is of no great importance. I believe the BURBANK memorandum I referred to is genuine but statements made in his 12-volume book must be accepted with discrimination. Some of them were undoubtedly made by BURBANK while others, obviously, were not.

I have stated that the editor, HENRY SMITH WILLIAMS, was a highly experienced compiler of semi-scientific books. He had a long list of encyclopedias and other literature intended to popularize science to his credit. He apparently cared little for exactness, which makes it difficult to secure definite information from his set of BURBANK books. It is a pity that when he had the chance to obtain facts, figures, and dates from BURBANK as far as it will ever be possible to secure them, he did not make use of the opportunity. BURBANK himself kept scant records so that dates might have been difficult to obtain, but I have no evidence that the editors valued such information or tried to obtain it. Apparently the task that had been given to HENRY SMITH WILLIAMS, as chief editor for the Luther Burbank Society or the Luther Burbank Press, was to write a readable book that would sell and, whether so instructed or not, he evidently conceived it to be his job to glorify BURBANK and make a great hero of him. (See Chapter VIII.)

By 1888 BURBANK's nursery was netting him something like $10,000 a year, but he was so determined to embark upon a career of improving plants that in that year he sold a part of it to his partner, R. W. BELL. The latter assumed the propagation and sale of standard varieties of nursery stock while BURBANK, of course, retained control of all of his novelties. In 1889 he in-

troduced his Burbank plum and ten new varieties of gladioli. From then on he turned out new things every year, but he did not consider that he had thoroughly arrived until 1893 when he issued his famous 52-page catalog, *New Creations in Fruits and Flowers*. He was already known throughout the United States, but this publication carried his fame to foreign lands.

BURBANK early adopted the plan of bringing a new fruit or flower to fruition, and then selling the entire stock to a purchaser for a lump sum in cash. He did not have the facilities for propagating and retailing very many of his originations and apparently did not want the responsibility of handling them. His chief customers, therefore, came to be the established nurseries and seed firms of the country. J. C. VAUGHAN, HENRY A. DREER, JOHN LEWIS CHILDS, STARK BROTHERS, and W. ATLEE BURPEE became his customers.

Beginning in 1893, according to his records, J. L. CHILDS entered the picture and became one of the largest purchasers of his wares. A great many of the new things were sold without names, or the purchaser had the privilege of renaming them. It was CHILDS who sold the so-called Wonderberry about which extravagant claims were made and which caused a controversy that did not subside for years, and echoes of which were still faintly reverberating at the time of BURBANK's death in 1926. This controversy was the outgrowth of the action of the judges of the Boston Flower Show, July 17, 1909, in declaring the BURBANK Wonderberry to be worthless. The *Boston Post* the next day said, "LUTHER BURBANK received the first severe snubbing yesterday when his latest creation, the Wonderberry, or Sunberry, was declared a failure. . . . The Sunberry is a hybrid produced by crossing the *Solanum nigrum* with the *Solanum africanum*, both of which are related to the potato and tomato . . . . was expected to prove a rival to the Blueberry." This plant was originally named Sunberry by BURBANK but was renamed the Wonderberry by CHILDS who published a collection of recipes entitled "100 Ways of Using the Fruit of the Sunberry or Improved Wonderberry." *The Rural New Yorker*, a crusading agricultural paper, pounced upon BURBANK and accused him personally of making false claims about his introduction. As a matter of fact, most of the claims were made by CHILDS, but it was never the policy of BURBANK to disavow laudatory statements made about himself or about his products. Also, it appears to have been a lifelong policy of his never to admit that any one of his products was a failure.

The earliest foreign nursery customer I have any record of was H. E. V. PICKSTONE of South Africa, who began buying Japanese plums in 1898 or earlier and continued to be a customer as long as BURBANK lived. JOHN M. RUTLAND of Australia was a customer for only a short time but a very profitable one. He started in by buying the Santa Rosa plum and the first plumcot which was named the Rutland. This was in 1905. Next year Mr. RUTLAND bought a long list of plums for which he paid over $6,000.

Later RUTLAND plunged on spineless cactus for which he paid thousands of dollars for the exclusive right to sell that succulent in the Southern Hemisphere. I have plenty of evidence to convince me that BURBANK actually bred most of the varieties of cactus that he sold. I have interviewed people who worked for him at the time, had a hand in the actual work of hybridizing, and I also have the evidence of Professor DE VRIES, the Dutch botanist, who visited BURBANK while the cactus breeding program was in progress. I wish to say here I am convinced that BURBANK fully believed in the worth of his cactus when he first promoted it. Later, he should have known better.

BURBANK was a strange combination of the naïve and the sophisticate — the latter word being used in the sense that he was far-sighted and a shrewd bargainer. But his far-sightedness sometimes took on the substance of dreams when he could make himself believe what he wanted to believe. He was so proud of the fact that he could do the impossible in the way of modifying plants — that is, what most people thought to be impossible — he was fond of saying that we can go to any limits that we wish in that direction.

Having lived a good part of his life in an arid country, his common sense should have told him certain things about what the cactus might be expected to do, but by the time he began dealing with this plant he had gotten into a state of mind where he could believe his own sophistries. He could have obtained first-class advice from people who lived in the semidesert country of Texas, New Mexico, and Arizona, but he was bulletproof against advice or even suggestions unless they happened to coincide with his own views. Perhaps this is not so strange when we think of the representative of the Australian government who came to California to make a special study of the possibilities of the spineless cactus with a view to introducing it into Australia for planting widely in some of their vast regions where rainfall is insufficient to produce grass. This man interviewed stockmen in Texas, a botanist at the Arizona Agricultural Experiment Station, and many others including BURBANK, and finally went home and made a voluminous report that the cactus seemed to be all that was claimed for it.

About this time swarms of letters began to be received at the Agricultural Colleges and Experiment Stations and at the United States Department of Agriculture, Washington, District of Columbia, inquiring whether the claims about BURBANK's products were true. Since the major portion of these claims were being made by nurserymen who bought things from BURBANK and who had gone BURBANK one or even several better in their extravagant statements about this and that, the authorities naturally had to say that most of the reports would have to be discounted from fifty to one hundred per cent.

Spineless cactus was one of the bones of contention between BURBANK and his friends and officialdom in Washington and in the states. Friends of BURBANK, making use of the criticism

levelled at him by government officials, sought to make capital out of the situation by having Mr. E. A. Hayes,[28] a California representative in Congress, introduce a bill authorizing the United States Department of the Interior to set apart twelve sections of semidesert or desert land (7,680 acres) in one of the semiarid states to be turned over to BURBANK for further experiments with cactus. This bill[29] was actually passed by the House of Representatives but failed of approval in the Senate.

In 1909 BURBANK agreed to sell the right to merchandize all of his products and a company was organized for the purpose, but at the last minute he reneged on the contract before the business could get under way.

It was stated elsewhere that there is sharp competition between firms dealing in seeds and plants and that their very lifeblood is the new things they can offer, so it is not surprising that many florists now began to complain about BURBANK and his products being over-publicized; but as far as I can see he did not do a thing that they themselves would not have done if they had had the opportunity. In their ranks were many persons who had originated new varieties of flowering ornamentals and each one, of course, was proud of his plant "baby". For BURBANK to come along and advertise scores of new varieties was too much for them to bear in silence, so the explosion came. The following account is culled from the columns of the *Pacific Rural Press* of San Francisco, under date of August 14, 1909:

"The most sensational agricultural event of the week is the arraignment of Mr. LUTHER BURBANK at the bar of horticultural judgment. We have apprehended its coming for a long time. We have not hesitated to state in these columns that the extravagant exaltation of the man and his achievements by those who really did not know either one or the other was, in our view, the most serious menace to his career, because it caused him to be misjudged and his work to be misunderstood. *The logical reaction from fulsome adulation is denunciation* and this is the phase which Burbankian development has now reached. It had to come; it is better now than later:

" 'Be it resolved, the Pasadena Gardners' Association hereby strongly condemns the nature-faking methods and exploitations of alleged but false creations by LUTHER BURBANK, and deplores the fact that a false impression has been given the public concerning plant breeding by BURBANK; it is the sense of this association that this impression should be corrected.'

---

[28] The Press-Democrat, Santa Rosa, California, March 2, 1912. Representative HAYES of California delivered a speech in Congress asserting "That in the Department of Agriculture there has lately been manifested a desire to belittle this great man and his work and to hold him up to ridicule." HAYES explained the magnitude and value of his achievements. . . . "99% of the plums shipped out of California," he said, "are of the varieties originated by BURBANK and practically all the potatoes." Congressman HAYES was not specifically endorsing the value of spineless cactus so much as he was defending BURBANK's reputation for attainment.

[29] H. R. 23043, 1912.

"This indictment is said to have been unanimously voted last week by about a hundred people duly assembled at a meeting of the society named in the resolution. It is, in work and spirit, fairly representative of the attitude which a considerable number of professional gardeners and commercial florists hold toward Mr. BURBANK's work. His plants do not enter to any extent into their stock, which is chiefly comprised of varieties originated by specialists working in their special lines and to whom they extend loyal deference. Naturally, these stars shine bright and large in this narrow horizon and no one denies them right to the homage of their worshippers. Mr. BURBANK has worked in these branches and demonstrated wonderful achievement. He blazed the way which some of these florists' specialists have followed and have won distinction in the eyes of their peculiar constituency. All would have gone well if the envy and ill will of this contingent had not been excited by the extravagant, distorted and untrue accounts of Mr. BURBANK's motives, expectations and methods which have been rife in the popular press. Men, who seem to them great, have been ignored. BURBANK, whose 'stuff is no good', as they wrongly but honestly claim from their point of view, has been almost deified. They become indignant, they lose capacity for calm and cool judgment, they cry aloud.

"As we have said, we have apprehended just this situation and have feared it, not from any permanent effect upon Mr. BURBANK's fame, but because of the embarrassment and ill feeling and the utter waste of effort required to overcome it. Mr. BURBANK feels the weight of this trouble. In an interview since the Pasadena proclamation, he is credited with saying:[30]

"The extravagant estimates of my work have been the bane of my existence. There has been much written about me by sensational writers who know nothing either of me or my work. I am not responsible for all these things and anyone with any knowledge of horticulture could discern at once that much of the stuff sent out is nothing but the space-writer's chaff."

BURBANK had been so much publicized and was now so widely known that he had many offers to sell out or take someone into partnership. However, he was still a one-man institution. Finally in the spring of 1912, for the second time, he contracted to sell all his past, present, and future creations involving what was termed "one of the biggest deals of its kind in the world."[31]

---

[30] San Francisco Chronicle, August 10, 1909.

[31] Santa Rosa Press-Democrat, Santa Rosa, California, November 2, 1912.
"The formal transfer of the commercial side of LUTHER BURBANK's business to the new corporation which is henceforth to handle the BURBANK seed and plant creations exclusively, was made on Thursday, ROLLO J. HOUGH and W. GARNER SMITH representing the purchasers." Mr. HOUGH said, "The final steps have been made in taking over the commercial end of LUTHER BURBANK's business. In fulfillment of the conditions of the sale effected last April, Mr. BURBANK turned over his business Thursday and from now on will devote his whole energies to his creative work.

"It is our purpose to push the seed and nursery end aggressively for we

The Luther Burbank Company lasted but little over three years when it was thrown into bankruptcy as a result of a suit filed by BURBANK to recover money said to be due him on a promissory note.[32] His attorney declared that he had been the victim of "stock pirates", and that other suits would be filed.

BURBANK claimed he would have brought suit much earlier than he did had he not harbored a forlorn hope that the company might pull through. He attributed the failure of the business to mismanagement. As a matter of fact, the company undertook the impossible when it began advertising practically everything that BURBANK had ever put out and apparently in unlimited quantities. It has been explained before that BURBANK never kept much of a stock of any of his products on hand, it being his habit to sell out completely of each item as soon as it was ready for marketing. If there were a few pounds of seeds and a few trees each of several varieties of fruits on hand, it would require at least three seasons to multiply them in sufficient quantities to fill orders on a national scale.

There were charges and countercharges, but the facts appear to be that the company officials, being entirely unacquainted with horticultural plants and the hazards that attend the planting of new and untested things, especially hybrids, confidently accepted BURBANK's enthusiastic descriptions and claims as to their value; and the inevitable happened, namely, that a high percentage of them did not make good. As many of the seeds were annuals, it required only one season for the customer to detect the misrepresentation, and further sales became increasingly difficult. This was a contributing factor in making it impossible for the company to meet its monetary obligations to BURBANK and stockholders.

As a matter of fact, the Company, in many respects, was but the lengthened shadow of BURBANK himself, as it accepted everything he said about his plants as facts and advertised them accordingly. BURBANK must have known that the Company was conducting a precarious business, inexperienced as the management was in the merchandizing of seeds and plants, but I can find no

---

are confident that it is possible to build up a business that will rank with the largest of its kind in the United States.

"It is likely that Santa Rosa will be made the distributing center and that seed farms and nurseries will be established in this vicinity, but with the exception of the Broadmoor Seed Farm near Oakland, no definite action has been taken in this regard. The business of the Company thus far has been conducted from our San Francisco offices.

"The corporation has ample resources to accomplish its purposes, up to $500,000, and is composed of a number of prominent bankers and business men of San Francisco, Oakland, and Santa Rosa, a certain portion of stock in the corporation having been allotted to those friends of Mr. BURBANK in Santa Rosa who desired to be identified with the new company.

"All the desks and typewriters were taken from BURBANK's home yesterday, together with his correspondence files and his account books. No longer will he need the services of a secretary and bookkeeper. He can give all his working hours to the labor of his life, and undoubtedly the result will be a new pace of achievement, a greater number of wonders to astonish the world. Henceforth, LUTHER BURBANK will have nothing to sell to anybody. . . ."

[32] Santa Rosa Press-Democrat, Santa Rosa, California, December 31, 1915.

evidence that he ever tried to do anything about it; and certainly he was always willing to continue selling to them as long as they would buy. In principle, this was in accordance with his usual practice, but the difference in this case was that whereas formerly he had sold one or only a few articles at a time — and always for cash — he now was obligating himself to sell everything he had or ever would produce, and accepting notes — for the most part — from the vendee, instead of cash. He evidently did not see any reason why he should concern himself with the advertising methods this or any other company might employ in selling his products— all he cared about was receiving the money that had been promised him.

It is a matter of viewpoint as to whether, under the circumstances, BURBANK was culpable. Many a business man would have done the same thing. The chief wonder is that he did not realize that his reputation was being undermined because his name was being used so recklessly. As a matter of fact, the public never has understood that all of the selling of BURBANK's products during the years 1913-1915 was entirely out of BURBANK's hands. Throughout the United States, exclusive of California, I have scarcely found one person in a hundred who ever heard that the Company was separate from BURBANK. A few had heard of the Company but thought it had been organized and was managed by BURBANK in person. It was this Company that made most of the extravagant claims for spineless cactus although BURBANK had paved the way by making some whopping big claims himself.

The Company seems to have taught BURBANK one thing: dealing in seeds was more profitable than dealing in nursery stock. After the Company had been successfully repudiated and his affairs were again in his own hands, he gradually gave up the tree business and confined his activities to the production of seeds of various kinds — flowers, vegetables, and grains — for he soon began issuing catalogs of seeds and bulbs[83] with a sprinkling of fruit catalogs in which he listed all of his more important plum introductions after they were supposed to have been sold "lock, stock, and barrel," as he once said, to various nurseries. At first the seed catalogs listed only things that BURBANK claimed to have himself originated, but later he also included a list of standard varieties. Still later, there was no way of identifying items as to whether they were new or standard.

During the last years of his life BURBANK farmed out his tree growing to another nursery which grew them under contract,[84] while he dealt in nothing but seeds and bulbs. Perhaps his advancing years made this necessary, for he was no longer physically able to perform the severe duties of looking after his collection of trees, attending to the pollination, and caring for his nursery.

[83] BURBANK's 1917 new creations in seeds, and some older ones of special value. — BURBANK's bulb catalog and how to judge novelties. — The new BURBANK wheat. — BURBANK's 1918 new standard grains.

[84] The Armstrong Nurseries, Ontario, California.

Apparently a great many of the flower and vegetable seeds listed as "new creations" were F_1 and F_2 generation hybrids of standard varieties, the crosses having been made in many instances in a wholesale manner by growing the varieties in adjacent plots and letting insects be the pollen carriers.

Having lost money in his dealings with the Luther Burbank Company,[35] it required some time to get on his feet again financially. During the early twenties and up to the time of his death he was gradually building up a very profitable business in selling seeds. After his death, there being no one to carry on the work, his widow sold the entire business to STARK Brothers of Louisiana, Missouri, under two contracts:

(1) For the name and good will of the bulb business and all of the seeds, and with the names and index cards of all customers; implements and supplies, and all catalog material; cuts, pictures, photographs, variety names, copyrights, trademarks, phrases and slogans used in the business, and

(2) For the exclusive right to all uncompleted experiments with fruits at Sebastopol for a period of ten years including those fruits mentioned in the *Final New Fruits Bulletin* which was issued in 1927, but not including the Royal and Paradox walnut trees. This contract also included the right to "certain grafts and buds sent to the Armstrong Nurseries at Ontario, California," which STARK's took over to propagate and sell on a royalty basis.

STARK's also reserved the right to renew these contracts for terms of five, ten, fifteen, twenty-five, or forty years. STARK's made some arrangement later under which they were allowed to sell the Royal and Paradox walnuts, there being one large old Royal tree at the Sebastopol orchard and a Paradox in the BURBANK garden in Santa Rosa. STARK Brothers evidently did not find the bulb and seed business profitable as they did not exercise their option to renew the contract. But in 1937 they did renew the other contract for an additional ten years.

STARK Brothers have set up at Louisiana, Missouri, what they call an experimental garden wherein are grown as many of BURBANK's products as they have been able to obtain but chiefly those things they control under their contracts with Mrs. BURBANK. They call this garden "Stark's Luther Burbank Experimental Farm."

After closely observing the collection of seedling fruit trees which BURBANK had growing in his Sebastopol Experimental garden at the time of his death, STARK's have introduced many of them as new varieties, 34 to be exact, under a new Federal regulation which permits them to be covered by plant patents taken out

---

[35] Personal conversation with BURBANK in September, 1915. Referring to the Company, he said bitterly: "They swindled me out of everything I had and I shall have to start all over again." Strong words, but like sundry other statements of his, to be taken with a grain of salt. In truth it seems to have been a case of having been hoist by his own petard.

in the name of Mrs. BURBANK through an arrangement whereby she receives a royalty on every tree sold.

BURBANK did not leave much income property at the time of his death although he held title to a few tracts of good ranch land in addition to the Experimental Orchard and the two gardens in Santa Rosa. A major part of the original BURBANK home place, consisting of four or five acres, was sold off as residence lots; and when no more could be sold on account of the financial depression of the early thirties, Mrs. BURBANK deeded the remainder to the Santa Rosa Junior College, retaining only the old home site, originally owned by BURBANK's mother, the old greenhouse which BURBANK used for over thirty years, and the studio building, with just a bit of land around them.

The tract of land across the street which originally consisted of four acres, upon which is located the large brick house which BURBANK built in 1906 and lived in until the time of his death, has been partially sold for residence purposes, and the building is used by a firm under the name of "BURBANK School of Business."

V

BURBANK THE SCIENTIST

IT IS my opinion that BURBANK died a disappointed man because he was not accepted by the world as a scientist. Whether he was one really is a matter of terminology because he did have many of the instincts of a scientist and did much — yes, very much, both directly and indirectly — for the cause of science.[36] His greatest achievement was popularizing plant breeding by demonstrating its possibilities, and this aroused public interest was the leaven that quickened men and institutions into activities that resulted in the advancement of the science of breeding by at least twenty years. It was the ballyhoo of his misguided friends that cheapened his attainments in the eyes of scientific workers and robbed him of the place he might otherwise have occupied in the literature of his time.

Of the considerable number of men in the 18th and 19th centuries who engaged in the hybridization of economic plants with the primary purpose of securing improved types and varieties and who won a place in the scientific annals of their day, BURBANK, by his aims and ideals, might best be compared to THOMAS ANDREW KNIGHT of England. KNIGHT believed inasmuch as the pear from southern climes had been adapted to the cool climate of England and the crab apple of England in the same manner adjusted to the frozen regions of Siberia, that it would also be possible to adapt the peach and grape to the unfavorable climate of England. In addition, he believed that it was possible to produce varieties for special purposes as regards both form and quality of fruit. It was not his idea that existing varieties could be made to accommodate themselves to special conditions and purposes, but that through hybridization new varieties could be produced to meet every purpose. At the first meeting of the London Horticultural Society, which he helped to organize, he read a paper[37] in which he set forth his views as to the purposes of the

---

[36] GOURLEY, J. H., Text-book of pomology. The Macmillan Company, New York, 1922. "The life and work of LUTHER BURBANK of Santa Rosa, California, has been a great stimulus to plant breeding. This is doubtless due to the great novelty of his creations and to the extent of his work. He has ever held in mind the production of fruits and other plants which would be of the greatest use and economic value and has held as secondary the accumulation of scientific data.

"Perhaps pomology has profited more from his production of Japanese plums, and the seedlings and hybrids which he has obtained from them, than from any other achievement. He has succeeded in hybridizing diverse forms of fruits, some valuable for commercial purposes and others as novelties."

[37] KNIGHT, THOMAS ANDREW, Introductory remarks relative to the objects which the Horticultural Society have in view. Trans. of the Hort. Soc., London, April 2, 1805.

Society and some of the things it should encourage its members to do. "Almost every plant," said he, "the existence of which is not confined to a single summer, admits of two modes of propagation; by division of its part, and by seed. By the first of these methods we are enabled to multiply an individual into many; each of which, in its leaves, its flowers and fruit, permanently retains, in every respect, the character of the present stock. No new life is here generated and the graft, the layers, and cuttings, appear to possess the youth and vigor, or the age and debility, of the plant of which they once formed a part. No permanent improvement has therefore ever been derived, or can be expected, from the art of the grafter, or the choice of stocks of different species, or varieties. . . . Seedling plants, on the contrary, of every cultivated species sport in endless variety. By selection from these, therefore, we can only hope for success in our pursuit of new and improved varieties of each species of plant or fruit. . . ."

Like BURBANK, KNIGHT's whole interest was in the production of useful plants but unlike BURBANK, he described his experiments in great detail at meetings of the Horticultural Society because he wanted the opinions of his colleagues. BURBANK rarely told anything about his projects until they were finished and then only in connection with the description of the new variety as he offered it for sale through the medium of one of his catalogs or price lists. His descriptions of his fruits and flowers were not those of a scientist, but that of a nurseryman. One looks for detailed and exact descriptions and finds a sales talk. His development might have been different had he not been compelled to sell his productions. He never took the trouble to make a report on his accomplishment to a horticultural or scientific meeting or to a scientific or popular publication. Why he did not we are left to conjecture. He has told us in his writings that he did not have time to keep detailed records on his hybrids or to write about them for publication. And this was probably true as he attended to everything in person and always kept himself overloaded with work but the unfortunate truth is that he had had no training in scientific procedure to give him an appreciation of the value of records or of having the results of his experiments mentioned in the scientific or technical literature of his day for the purpose of advancing knowledge and being helpful to others. This was the vital defect that prevented his being accorded the degree of fame he intrinsically deserved. Also, it undoubtedly accounts for some of his eccentricities. It is my belief that he did not want the opinions of others, and his nurseryman's instinct warned him to beware of disclosing what he regarded as his trade secrets to his rivals. He wasn't thinking of the public or the scientific world but of his fellow nurserymen. It is barely possible that he was seeking to emulate DARWIN who was a lone worker for many, many years before making known the results of his labors.

I have found no evidence to indicate that he was familiar with the writings of KNIGHT, FORSYTH or the famous Belgian hybrid-

izer, VAN MONS, who gave the world so many new varieties of pears. He was not only a lone worker but an individual or independent thinker. DARWIN gave him the idea of the possibilities of plant improvement and from this point he advanced alone, with supreme confidence in his ability to follow the paths DARWIN had pointed out. His program was original with him, he confided in no one, and did not even benefit by reading the history of what others before him had done.

One of the reasons why the institutional scientists of the country were chary of him was that he was not university trained, did not hold a degree. Institutional scientists the world over constitute a sort of caste system. They recognize that there are plenty of people with college degrees who are not productive scientists, but without a degree and the institutional training that a degree implies, it would be hard to secure a hearing, much less to be accepted. This is the first reaction of the institutional scientist toward the newcomer seeking recognition but I hasten to explain that scientists may be roughly divided into two groups, pure and applied, depending upon whether they are seeking the truth in the abstract or in the concrete, and those in the first group are likely to be less sympathetic toward BURBANK's accomplishments than those in the second. The first are chiefly concerned with fundamentals — the discovery of universal laws and precepts in the various fields of human knowledge without regard to their specific use, while the other may follow the same procedure or make use of the principles their colleagues have discovered, then proceed to apply them toward the solution of particular problems.

Pure scientists adorn some of the brightest pages of the world's history. Mostly they labor without hope of reward. Some have been martyrs. All honor to them, especially in these days when many are called but few are chosen. All young Ph.D.'s are zealous candidates. It has been science — pure science — from COPERNICUS and GALILEO onward that has been the torch that has led us out of ignorance and superstition. But to the applied scientists must go the honor for our greatest material advancement. Both are necessary. The applied scientist may use pure methods or pretend to do so. On the other hand, he may imagine that he is so pure that he would be dishonoring his cult and stultifying his talent to concern himself with things utilitarian. Happily these constitute a small minority. Privately endowed educational and research institutions employ thousands of scientists, mostly for the advancement of knowledge — non-utilitarian. Federal and state agencies maintain additional thousands on research status for humanitarian purposes — education, production and utilization of food and raiment, esthetics, better living — all essentially utilitarian. Agriculture alone in all its branches maintains a little army of research workers — between fifteen and twenty thousand — whose aims are principally utilitarian. These are employed by the United States Department of Agriculture and the agricultural colleges and experiment stations of the various states. Industry, too, both

corporate and individual, engages in research for its own ends — to become more efficient and successfully meet competition in a material world.

Research involves both philosophy and experimentation. Logic usually determines what the program of experimentation shall be but the technique to be followed may have to depend upon circumstances, upon technological knowledge, craftsmanship, equipment and the like. Research presupposes either wide intellectual training or special knowledge or experience in some particular field or domain. There are many degrees or grades of research, the lowest in scale according to present day standards being the empirical, or so-called cut-and-try variety. Up to fifty or seventy-five years ago much — perhaps most — of our material advancement was by this method for the good reason that popular education was not sufficiently advanced to equip workers for doing otherwise. It was not until about 1870 that chemistry was placed on a scientific basis by the acceptance of MENDELEEFF's periodic law, and another decade or so elapsed before "natural philosophy" was succeeded by the science of physics. A few students of that day, who enjoyed exceptional opportunities, were able to receive fairly good scientific instruction in animal physiology and anatomy but there was not much teachable knowledge of plant physiology and anatomy available until toward the end of the century. The science of genetics was not born until the rediscovery of MENDEL's laws of heredity in 1901.

BURBANK's formal education — such as he had — occurred when he was eighteen years old. He attended Lancaster Academy in his native village for a year, he tells us, perhaps the latter part of 1867 and the early part of 1868 — as country boys could be spared to go to school only in the fall and winter time. Old catalogs of the school now in the library of the American Antiquarian Society in Worcester, Massachusetts, show that his name was on the roster of pupils for both years. By present standards this seems like a sketchy education, but seventy-five years ago most boys were not able to do that well. He was fortunate in being located so near a famous school that turned out many notable men, for the Lancaster Academy, a high-class prep school for Harvard and Yale, attracted students from beyond the borders of the state. Just what subjects BURBANK pursued is not clear but he has said that he had thought of studying to become a doctor of medicine which indicates his scientific bent. Science subjects listed in the second, third, and fourth years of the Lancaster Academy curricula included mathematics — algebra, geometry, surveying, natural philosophy (physics), physical geography, and physiology. Unfortunately his schooling was cut short by the death of his father and he set out to make a living for his widowed mother by starting a market garden. In this pursuit he began his experiments in the hybridization of vegetables.

So far as we can see, BURBANK's schooling had little to do with determining his life work. However, it no doubt developed

his mind and broadened his horizon. He had a natural liking for plant improvement and his reading of DARWIN's books fanned this liking into a passion. He possessed the first requisite of a scientist — curiosity as to what would happen when two plants were crossed. There had been no influence in his life — educational or otherwise — to impel him to seek knowledge for its own sake and he was neither a philosopher nor a dreamer of idyllic dreams. On the contrary he was a practical-minded country boy with an urge to explore but who could see no reason why his findings should not serve some useful purpose. To do otherwise, to perform experiments for his pleasure alone, he would have stood condemned in his own eyes, as well as in the eyes of others, as an idler, a waster of time, a conclusion dictated by environment and upbringing.

It is interesting to speculate on what would have been the effect on his later life had he been able to spend a few months with AGASSIZ or ASA GRAY at Harvard — less than forty miles away — at this time. He might have followed the path of pure science. But fate decreed otherwise and he laid out a career for himself, according to his own lights, that was at once bold and unconventional; bold because he was evidently unfamiliar with what experimenters had done in Europe toward improving cultivated plants by means of crossing types and varieties; unconventional because our research institutions were unprepared by experience to endorse a program that grew so rapidly into monumental proportions.

While most of the states in the late eighties and early nineties were equipped with agricultural colleges and experiment stations — manned in all cases with college graduates — their experimental activities consisted mostly of variety tests, fertilizer trials, feeding experiments, and routine analyses — all quite empirical, which, in principle, was just what BURBANK, all alone and without a degree, was doing at his "Experiment Farm" out in California. True he was not testing varieties or making analyses but he was making wholesale crosses of types and varieties of fruits and other things by a hit-and-miss original method of his own and thereby producing (creating?) new varieties.

The experiment station workers with their limited number of tests kept careful account of their operations while BURBANK with his numerous simultaneous experiments had to be satisfied with only a pocket notebook with loose leaves on which he scribbled the merest outline of his doings from day to day and relied on his memory for the rest. Both achieved the results sought, in the sense that they, each, had visible and recorded evidence bearing upon the problem in hand but the station workers felt that their success was due to scientific procedure while the other was not. Tradition and training made this view inevitable.

As a class, institutional workers were instinctively mistrustful of BURBANK because he was unknown to the clan, had not attended their organization meetings or written for their publications, was unconventional in his experimental methods, and was an outsider.

When a considerable number of objections are cited in a case of this kind it is usually the last one that carries the most weight.

Institutional scientists have certain unwritten rules by which they judge themselves. These are commonly known and are well understood by all of the accepted scientists of the day. Because of the caste system then, it would have been almost as much of a miracle for BURBANK to be accepted by all of these aristocrats of knowledge as it was for the camel to pass through the needle's eye. If you are not to the manner born, so to speak, you are not apt to be taken seriously.

To be a scientist one must have been educated in an institution presided over by scientists. Back in the seventies and eighties and later, Germany was considered to be the land of science and scientists par excellence, and to that country flocked students from all over the world. Returning home, these students steeped in German methods and traditions quickly and effectively transplanted the German system to the laboratories of our leading institutions of learning to their everlasting betterment. But on bringing over their methods of undoubted excellence, they also brought along the German caste system as well, which was not so good. Of course, this caste system was never exactly reduced to a pattern as in our army regulations (also copied from Germany), and perhaps never consciously recognized as a caste; but we had it just the same and remains of it yet linger, here and there.

To belong to the caste, one must above everything be willing to conform. To be sure, as before stated, the rules are unwritten but in some respects they are as exacting or inexorable as the military code. The deplorable extent to which professional jealousy existed among European scientists, particularly in Germany thirty to forty years ago, appeared to me to be a concomitant of their caste system. During my student life and afterwards over a period of thirty years I had many personal friends in the faculties of three of their universities. In every case, where they had the opportunity of visiting our American institutions, they expressed astonishment at the way our scientific workers showed visitors through their laboratories and explained in detail their current researches, even though the visitor might himself be working in the same field. A few were inclined to be cynical and thought we were naïve. These would remark, "Are you not afraid they will steal your secrets?" Mostly, though, they liked our custom and deplored their own lack of confidence in their professional colleagues. I was told of cases where a visitor would discover that a rival professor was about to conclude a research when he would hurry home and rush into print with a paper, no matter how incomplete, in order to sterilize or at least to vitiate his rival's forthcoming report.

As a graduate student in Germany I had a closeup of some of their professional rivalry. In selecting a place to work it became necessary to make a choice between two laboratories in plant physiology, one presided over by a man 60 years of age with

an international reputation for his books and researches and consequently besieged by students, and another in charge of a man 12 years younger who was just beginning to taste the joys of fame and of course, with not so many students and these mostly persons who had been turned away from the other institution. For personal reasons, though mostly through chance, I elected to go with the younger man. When he learned that I had declined an invitation to work with his famous rival, I was received with a heartiness that I could not understand, but did later when I learned of the rivalry between the two. The attitude of my professor toward this colleague in a neighboring institution was not one of emulation but of pure envy. However, I deemed this to be no business of mine but I was an interested observer.

BURBANK was a scientist but not a conventional one. As one writer says,[38] "As a worker in applied science, BURBANK may be placed with other Americans whose originality and resourcefulness have led to notable discoveries as FRANKLIN, FULTON, MORSE, BELL, and EDISON."

"BURBANK was hardly a scientist in the stricter academic sense of the word," says HYLANDER,[39] "but as DAVID STARR JORDAN once said, 'It seems to me that Mr. BURBANK, while primarily an artist, is, in his general attitude, essentially a man of science. Academic he doubtless is not, but the qualities we call scientific are not necessarily bred in the academy. Science is human experience tested and set in order. Within the range of moulding plants, Mr. BURBANK has read carefully, and thought carefully, maturing his own generalizations and resting them on the basis of his own knowledge. In his field of the application of our knowledge of heredity, selection, and crossing to the development of plants, he stands unique in the world. No one else, whatever his appliances, has done as much as BURBANK, or disclosed as much of the laws governing these phenomena. BURBANK has worked for years alone, not understood and not appreciated, at a constant financial loss, and for this reason — that his instincts and purposes are essentially those of a scientific man, not of a nurseryman nor even a horticulturist. Scientific men belong to many classes; some observe, some compare, some think, and some carry knowledge into action. There is need for all kinds and a place for all'."

BURBANK himself has stated[40] that he thought of himself as a scientist, and oftentimes throughout his life he did knock at the scientists' door and demand admission. Feeling that he was a scientist and knowing that he had a long list of plant hybridization accomplishments to his credit, and having been told so many times by his admirers that he was a scientist, he could not understand why he was not welcomed into the magic circle. His enthusiastic

[38] COOK, O. F., Saint Luther, a BURBANK cult with an account of his wonder-working methods of plant breeding. Journal of Heredity, 20, 7:309-318, July, 1929.

[39] HYLANDER, C. J., American Scientists. The Macmillan Company, New York, 1935. Chapter on LUTHER BURBANK, pp. 105-122.

[40] HALL, WILBUR, Harvest of the years.

admirers also could not understand it. Unfortunately, some of the number advanced the theory — and it was generally accepted by the group — that there was a conspiracy on the part of the accredited scientists of the country, fostered by the institutions with which they were connected, to discredit him and keep him out. Jealousy was given as the cause and I have good reason for believing that BURBANK himself took considerable stock in this belief and I am quite sure that his last years were embittered because he thought he deserved, and had a right to expect, better treatment at their hands; it was tantamount to a betrayal, so in this state of mind there should be no surprise at his bitterness.

Without a conventional scientific education and having lived an isolated existence with his beloved plants, he was unacquainted with the standards of scientific men and how they judge each other and their work; how a man's rating does not depend upon his personality or what he says he has done or what others say about him unless they, themselves, are people of established reputation in the field of science and therefore thought capable of judging; so he could not possibily understand their viewpoint. On the other hand he was acquainted with the habits of nurserymen and florists who made a business of growing plants to sell. He knew their problems and how they were likely to react toward a competitor, that their envy might wax in proportion to the degree of his success as a vendor of plants; all of that he was familiar with, but he made the mistake of attributing ulterior motives to one group because he knew from experience that another group, for understandable reasons, might, on occasion, say unkind things about him.

I am convinced that BURBANK possessed the talent and attributes of a conventional scientist and there would have been no question about his acceptance had he been taken in hand when young and given the proper training demanded by the code. He was curious by nature, persevering, patient, and was endowed with a fertile imagination. He was bold, original, had a quick, discerning eye and apparently his powers of reasoning were good. His memory was marvelous as is attested by the multiplicity of his tasks and the meagre records he kept to guide his activities. In one respect at least, BURBANK did not display the attitude or spirit of the true scientist: there is no evidence he was ever stimulated by criticism. On the contrary, criticism or disagreement with him or his conclusions in any way always seemed to irritate him. To compare a variety of his fruit or anything else with a preexisting variety was taken by him as an implied criticism and he was quick to resent the slight, thus displaying his egotism at its best, or its worst.

Another reason why he was not looked upon as a scientist by many was that he did not have the attitude of a scientist; the basic urge he had for experimentation was utilitarian, to produce something that was salable rather than to make contributions to knowledge. One of the main reasons that he was not accepted as a scientist was that he did not keep proper records of his crosses.

His experiments were mostly uncontrolled. He rarely took the time or trouble to emasculate the flowers before applying pollen or to protect the hand-pollinated flowers from receiving foreign pollen through the aid of natural agencies such as wind and insects. In many instances he simply did not bother to find out where the pollen came from that fertilized his flowers because all he wanted was a large number of hybrids with as much variation as possible among them. This he knew from experience could be brought about by his method of wholesale pollination; and it may be remarked here that this was perhaps his biggest *direct* contribution to the science of plant breeding.

The idea was not original with him, to be sure. He got it from reading DARWIN. But he should be given full credit for developing the idea and demonstrating its truth and its practicability. It was this procedure that intrigued DE VRIES and caused that famous Dutch botanist to visit BURBANK in 1904 and again in 1906. Ostensibly he was on a lecture tour but BURBANK was the magnet that *drew him to California.* "For many years I had wished to make a study of fruit culture in California," wrote DE VRIES,[41] "and especially of the production of new varieties. One reason which, more than others, made me accept an invitation to visit California was the prospect of making the personal acquaintance of LUTHER BURBANK . . . .

"As soon as I had decided about my plans I wrote to BURBANK and told him my desire. I had previously been in correspondence with him, and a few years ago I had hoped to meet him at the Congress of Hybridologists in London, but his arduous labors prevented him from being present. I feared even now that there would not be many chances of speaking to him, because July is his busiest time, when all the numberless crossings are made and the selection of prunes [plums] takes place . . .

"My wish to see him was, however, met with the greatest cordiality. Others had naturally the same desire, and we were consequently all invited to come together to Santa Rosa, where BURBANK lives, and to inspect, under his personal guidance, his experimental plots. He set apart an evening and a whole day for our visit. How many crossings and selections he had to sacrifice for this I do not know. Our party was a rather large one. There was first Professor SVANTE ARRHENIUS — the man who with VAN'T HOFF laid the foundation of modern physical chemistry. Among all the savants I ever had the fortune to meet, he certainly is the man with the widest knowledge and the broadest interests, and his opinion about BURBANK's methods was of the greatest value to all of us. In our party was also the physiologist,

[41] HUGO DE VRIES, A visit to LUTHER BURBANK. Popular Science Monthly, pp. 329-347, August, 1905. Authorized translation from the Dutch by Dr. PEHR OLSSON-SEFFER, Stanford University. "This article was written by Dr. H. DE VRIES, the eminent botanist and originator of the mutation-theory, while in California last summer. It was originally published in the magazine 'de Gids' in Holland, and forms a part of the third chapter of a book 'Naar Californië' by DE VRIES, which appeared recently in Amsterdam. . . . "

JACQUES LOEB, the discoverer of many important phenomena in regard to fertilization in lower animals. His studies have led him to the question of the causes of life and of those life-functions which give animals and plants their characteristics, expressed in the differences of kinds and varieties. These characteristics cannot be studied to advantage except by means of hybridizing. So far no one in the whole world has made crossings on a larger scale than BURBANK, and it was only natural that there should be many points in common between the studies of both these men. Our party was under the guidance of Professors WICKSON and OSTERHOUT, of the University of California. Both are personal friends of BURBANK, and, notwithstanding the distance, often visit him to keep posted on the progress of his work.

"In outward appearance BURBANK is a very plain man, more a gardener than a savant, with clear blue sparkling eyes, full of life and fun, appreciating humor in others, telling us stories that kept us constantly laughing. He lives in a small house with his mother and sister, and has but one servant on the place, as he does most of the work personally. The walls of his room are covered with small photographs of his victories, and during our visit these pictures were taken down and demonstrated to us."

DE VRIES then discussed the extremely large numbers of hybrid plums BURBANK dealt with in producing the Alhambra variety, also his experience in crossing the wild beach plum with other American varieties as well as with the Japanese in order to combine the hardiness of the first with the eating qualities of some of the others.

"It is natural that by such crossing we must expect the appearance of undesirable characters as well as desirable ones. Some plants produce only good, others only bad, characters, but the greater part exhibit some good points in connection with a larger or smaller number of undesirable qualities. From hundreds of thousands only those must be selected which possess all the desired characters. To make this possible it is necessary not only to cross six or eight kinds with one another, but to use as many sub-species and varieties as possible for the experiments. This work necessitates hundreds and even thousands of experiments. The result of each crossing can only be judged by the fruit, and this indicates new combinations. It can easily be seen what an immense amount of work, patience and capacity of judgment and choice is required to reach the ultimate aim. Yet BURBANK told us on that remarkable evening of many such instances. He was enthusiastic in his hope to be able to realize all this during his life.

"The making of hybrids from the different species of plums naturally brought us to a subject which, for me, was of the greatest importance from a scientific standpoint. As ARRHENIUS and LOEB also felt more interest in the theoretical side of these problems, I took the first opportunity to bring the conversation to that point. I had in mind the 'pitless prune'. . . . When asked how it was possible to bring about such a great change (seediness to

seedlessness), that hybrids do not present, as a rule, any new simple qualities, only new combinations of already existing properties, BURBANK explained that he merely brought a natural *'prune sans noyau'* (plum without seed), from France, where it had been known as a worthless wild fruit growing in the hedgerows, and hybridized it with varieties possessing good eating qualities. Thus there is no exception to the rule, there has been no real production of a new character...

"To Professor LOEB and myself this was, to a certain degree, a disappointment. We had expected to learn a great deal about this point, the fundamental idea, if not ultimate aim of the studies of both of us — that is, the question of the nature and origin of new characters. We now surmised that BURBANK's experience did not throw any light on this question."

The case of "white blackberries" was also cited and discussed and it developed that again he had made use of a natural wild form with white fruits. Then came the "spineless" cactus and it turned out that he had collected Opuntias from Mexico, South Africa, and various countries as well as the commonly cultivated species. "Among the specimens BURBANK received, one was accidentally found without prickles on the leaves and another with no thorns on the young shoots. It was, therefore, necessary to combine in one plant both these negative characteristics, something that experience has shown can be done...

"What makes BURBANK's work entirely different from that of other plant breeders is the immense scale on which his selecting is made. He is, therefore, able to make greater improvements than others and in much shorter time. In his work BURBANK is guided by a special gift of judgment, in which he excels all his contemporaries. The best proof of this is to be found in the great success his creations have made, not only in North America, but also in Europe.

"His methods of work are the same as those followed by plant breeders in Europe. Secrets he has none, and if he is not willing to demonstrate his cultures to everybody, this must be attributed to the fact that his time is too valuable. There is no fear that anyone could 'steal his trade' by merely looking at it. Everyone is left free to follow in his path, but without the special disposition for it nobody will succeed, and for simple imitation, the entire process is too complicated...

"With crossing or hybridization we usually understand the sexual union of two individuals belonging to different species or varieties. In practical plant breeding, however, it is not sufficient to combine two types, but three, four, and even five, or six kinds are thus united, so as to bring out as many desirable qualities as possible in one single variety. It is, of course, impossible to predict what result will be obtained, and it must be left to chance and the future to decide what combinations are the most desirable. Often crossings are made only with the object in view that among all the combinations something good may turn up. In this case

the breeder wants to destroy the equilibrium of existing characters, to make the constant forms unstable, and then to select the best out of the many balancing properties. When the parents themselves are variable their offspring will naturally be more so, and the number of differences increases with the number of hybrids experimented upon.

"There is also a chance that latent or sleeping characters may be brought to light. From a scientific point of view we know, as yet, nothing about this, but BURBANK holds the opinion that in many cases one character prevents another from becoming visible. For instance, in crossing, the first one meets an opponent which has kept it back — as is often the case in the crossing of varieties — and this latent character gets an opportunity of becoming active. We can naturally not detect what dormant qualities are hidden in a plant, and may, therefore, expect all kinds of surprises. The combinations may be desirable, and the hybrids can be propagated immediately, or they may be the reverse and need further crossing before the unfavorable traits are eliminated. Unknown atavistic properties may in this way become evident and may play an important part in the development of future generations.

"In other cases the crossings are made with a certain purpose in view. These are the instances from which we learn the most, and which at the same time give the best chance for quick and favorable results. A certain number is selected of species or varieties, which together contain those characters we want combined in one type: The undesirable properties we try to eliminate. As the crossings result in all kinds of combinations, it is necessary to produce them in as large numbers as possible, so that among the numberless undesirable and imperfect plants we may choose the best. The chances are that from the five or six desired good characters only three or four are found together. Thousands of seedlings have to be developed in order to create a possibility of finding one form in which the expected qualities are present. It is a game of solitaire on a large scale. I may mention as an example of this the production of the Alhambra plum, which was obtained by combining European, American, and Japanese kinds. It took thirteen years to combine all these. First came the crossing of the Kelsey with the *Prunus Pissardi.* Their hybrid was crossed with French prunes. In the meantime various other crossings were created, and it was made possible to work the pollen of these 'into the strain' as the term is called. First came *Simonii, triflora, Americana,* and then *nigra.* This sevenfold combination gave us the variety now known in the market as the Alhambra.

"We can go still further and cross species that are yet more widely separated. It is then naturally even more difficult to predict the results. BURBANK endeavored to combine the plum and the apricot and succeeded in getting a new fruit, which he calls plumcot, of very delicious taste and looking very much like an apricot, but combining the soft skin of this fruit with the dark color of the plum. BURBANK had a number of varieties of his

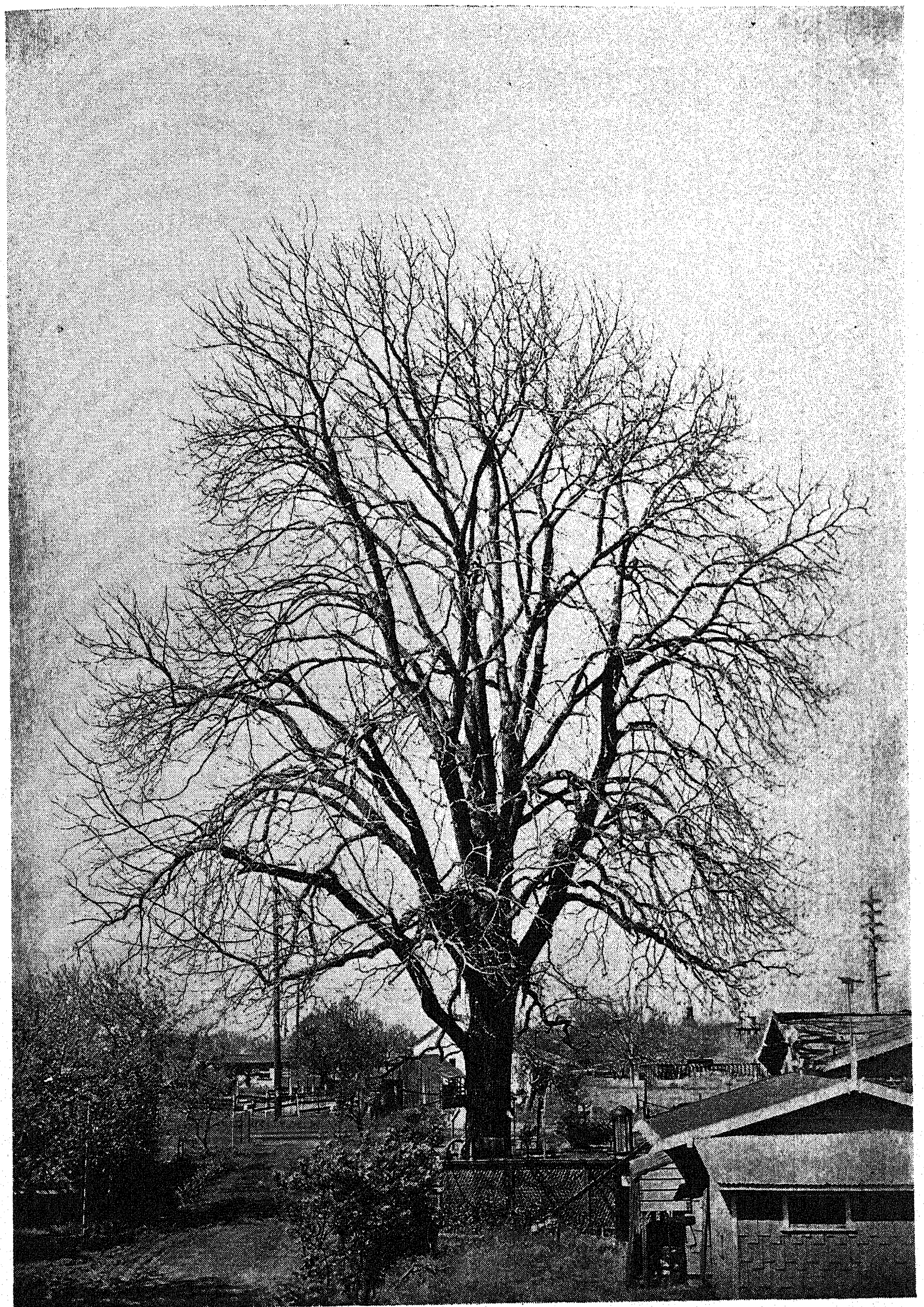
new fruit, some with a yellow fruit-flesh, others of dark red color, light rose, or white. In taste these plumcots differ considerably. . . .

"When novelties are wanted in varieties of begonias, geraniums, dahlias, or fuchsias, for instance, which annually produce many new forms, the hastening process would be of no value, but in new genera unexpected results are often attained, and in that case the hastening method will amply repay the expense. Yet these questions are the secrets of breeders. Of scientific importance is the question whether repeated selections are alone sufficient to bring about the same end, and further if by this means more variations are produced.

"We have no facts which would decide this, and I would not have brought up the question, had it not been for its great influence on the study of evolution. It is closely connected with the question whether species slowly merge into one another or whether they originate by mutations. In the former case small deviations would increase in the course of generations, and thus a long series of intermediate forms would connect the new and the old species. In the latter case a jump is made without any intermediate stages. So long as there were not sufficient instances of this mode of change, and so long as we had to rely upon cultivated varieties only as proof, the first proposition was naturally the most probable. It rested on experience in agriculture and horticulture in regard to improvements of races, and it was believed that species in nature originated in the same manner. The result of breeding on such a large scale as that mentioned above was at the time unknown, and it was believed that the results could be obtained only by repeated selections. If by experiments on a large scale the varieties could be produced at once, the former view would evidently lose much of its value.

"The magnitude of BURBANK's work excels anything that was ever done before, even by large firms in the course of generations. The number of fruits and flowers which he has improved is unequaled. Others confine themselves to one or two genera; he takes hold of everything. The majority of breeders who became famous by their improvements of certain groups took up this work merely as an adjunct, as a means of widening their commercial relations, thus creating a greater demand for their nursery products. BURBANK commenced in the same way, but as soon as he had obtained what he thought he required, the nursery business was abandoned, and he devoted himself exclusively to the improvements of flowers and fruit. It is to this resolution he owes his present fame."

This analysis of BURBANK's principles and methods of breeding is the best that has ever been made. DE VRIES came over with the thought in mind that many, perhaps all, of BURBANK's new plant forms could be attributed to mutation — abrupt appearance of new characters — but he soon abandoned this idea, chiefly because he had not produced new characters at all but had merely



A sixty-year-old Royal hybrid walnut growing in the dooryard of the JOSEPH W. MILLER home in Santa Rosa, California. Planted about 1884, this is believed to be one of the first five hybrids between the common black walnut of the eastern states, *Juglans nigra*, and the Northern California black walnut, *J. californica* var. *Hindsii*. In 1939 the tree had a circumference of ten feet, a height of one hundred feet, and a branch spread of 75×96 feet. It has produced a ton of nuts in a single crop. (*Photograph by* Mr. ARTHUR E. GILMORE.)

CALIFORNIA.

One of the few wood engravings used in LUTHER BURBANK's catalogues showing the *Gladiolus,* variety California ("the first double Gladiolus and the first of a type in which the flowers are closely arranged all around the spike like a hyacinth . . .") from "New Creations," p. 42 (1893).

re-combined existing old ones since this was all he claimed to have done; there was no new scientific principle involved and, therefore, no mystery about his accomplishments. However, DE VRIES made it clear that he greatly admired the man for what he had done and gave him full credit for having demonstrated the possibilities of mass breeding.

On the other hand, on the scientific side he expressed some disappointment, as has been stated. In addition, he privately expressed his disappointment, both on account of no new characters having been developed by BURBANK's methods of breeding and on account of the scarcity of records. These regrets were made known to a young Dutchman by the name of JOHN ZUUR, who was just over from Holland, working for BURBANK as a gardener's helper. At that time ZUUR understood the English language fairly well but could not speak it. No doubt it was a kindred feeling toward a fellow countryman who could converse in his native tongue that caused DE VRIES to speak so frankly to a stranger. At any rate ZUUR, who still resides in California, tells me he did so.

Still another and very potent cause of mistrust of BURBANK in the eyes of institutional scientists was his connection with schemes to merchandise his products. His nursery instincts and the rules of the game caused him to make prodigious claims for things he had to sell. And when he sold an individual or a company the exclusive right to market his productions, as recounted elsewhere, he got the credit for all the things that they said and did. No man can be thought of as a true scientist who would make the claims he or his agents did in order to sell something.

These merchandizing stunts, with their attendant publicity, alienated the sympathy of many who, otherwise, would have been his supporters. I have found it to be a fact that some, although knowing he had originated numerous valuable fruits and flowers, were, on account of the things that have been narrated, still inclined to mistrust even this positive evidence of his value to human welfare, and finally allowed themselves to come to the conclusion that perhaps, after all, BURBANK was the shady character that the extreme critics all along had said he was.

Further reason why BURBANK was mistrusted by scientists was his proneness to go off at a tangent in his thought, as evidenced by his incursions into speculative philosophy, metaphysics, and psychology.[42] [43] HUGO DE VRIES once criticised him "for making statements on subjects outside of his field; the wrong he had done to himself because he wanted to give to his work scientific significance."

---

[42] ATKINS, ALBERT J. and EMMA A. LEWIS, The mystery of gravitation explained. Refers to it as electric action. LUTHER BURBANK approves main principle of theory. San Jose Mercury, November 19, 1905.

[43] FAIRCHILD, DAVID, The world was my garden. Charles Scribners Sons, New York, 1939. "I was surprised and nonplussed to find that BURBANK believed in clairvoyance."

DE VRIES had reason for being doubly disappointed at his visit with BURBANK, for he not only did not learn any secrets about how new plant characters are acquired but his own pet theory that they arise through mutations received a severe jolt. As stated before, BURBANK did not claim to have created new characters in his breeding operations but merely to have brought about recombinations of characters that had previously existed either in the parents or some of their ancestors. (Examples, the so-called pitless prune, white blackberry, scented lily, spineless cactus, and many others.) Of course, little or nothing was known about chromosomes and genes in 1906, and their significance as carriers of hereditary traits. These were discoveries of a later date. While DE VRIES was undoubtedly familiar with the structure of the living plant cell and at certain times may have observed a cloudiness in the nucleus — may have even heard of chromosomes — it is certain that BURBANK had never seen or heard of such things. I have found no evidence that he ever possessed a microscope or even read the scientific literature of his day. He did, however, have a vast fund of knowledge on the behavior of plants gained from twenty years' experience in hybridizing and searching for certain characters in the seedlings. And there is much proof that he was a careful observer. A man of keen vision and active mind, ever on the alert to find even minute characters that would serve as clues to the ultimate value of the plant, it is not surprising that he was able to find at least a few characters in seedlings that turned out to be correlated with adult characteristics. This faculty of observation was assiduously cultivated because it was necessary to find short cuts in his work, to get more done in a shorter time.

At one time or another he has had much to say about this gift and there seems to be considerable direct evidence favoring his claims although even scientific visitors have been prone to place too much credence in his own statements at times, not knowing or realizing that he was much given to exaggeration. DE VRIES gave him credit for possessing a special talent in selecting young seedling trees for future usefulness and exceptional judgment in picking from a large collection of hybrids, after fruiting only once, certain ones that later turned out to be successful varieties. As this was the period when BURBANK was originating his long list of varieties of Japanese plums, DE VRIES evidently referred to that fruit. But BURBANK probably never had an easier task in picking winners as Japanese plums at that time were practically unknown and thus the meanest of his seedlings were better than existing varieties. The Kelsey, introduced from Japan in 1870 by JOHN KELSEY of Berkeley, California, and disseminated by J. F. HOUGH of Vacaville, California, was our only variety, and this was so tender that it was not grown outside of California and therefore was known only locally. Other seedlings were brought in by W. P. HAMMON and H. E. AMOORE, under Japanese names, but apparently they soon disappeared.

KELLOGG[44] thus testifies to BURBANK's acumen in judging his material: ". . . . there is always immediately following the usual production of variations, the recognition of desirable modifications and the intelligent and effective selection of them; that is, the saving of those plants to produce seeds or cuttings which show the desirable variations and the discarding of all the others. In BURBANK's gardens the few tenderly cared for potted plants or carefully grafted seedling represent the surviving fittest. . . .

"It is precisely in this double process of recognition and selection of desirable variations that BURBANK's genius comes into particular play. Right here he brings something to bear on his work that few other men have been able to do. It is the extraordinary keenness of perception, the delicacy of recognition of desirable variations in their (usually) small and to most men imperceptible beginnings." This was high praise from a man who was an able scientist, young and critical. KELLOGG afterwards became permanent Secretary of the National Research Council.

Under the heading of "Correlation of Parts" BURBANK is reported by WILLIAMS,[45] his ghost writer, as having observed the following relations and correlations: "In selecting raspberry and blackberry plants for color of fruit, for example, there is almost always a correlation of the plant and fruit that will foretell the future crop. . . . I have observed that vines that have purple spines and canes will in future produce berries that are dark purple or dark red in color. Pinkish leaves, on the other hand, foretell fruit of light pink or red color; plants with reddish vines and foliage may be expected to produce berries of a yellowish color. Very pale foliage and canes usually indicate that the crop will be of a whitish or amber color. . . . .

"The correlation of characters between the vine and the fruit of the grape is not always quite so clearly established, yet it is often observable. Grape tentacles may give clear indication of the size and flavor of the future bunches of fruit. Long before a grape vine has come to the age of fruiting, the taste of the tendrils may give a fair idea of the flavor of the grapes it will ultimately bear. Moreover, the seedling vines that produce bush stems that are small and much branched, and have small leaves, will almost invariably produce meager clusters of small fruit of poor quality.

"Among plums and peaches the correlation of characters is exceedingly valuable. The case of plum seedlings, already cited where he walked down a nursery row and marked little trees a foot high either for acceptance or rejection — destruction — by merely giving them a glance, and where he did essentially the same thing by passing quick judgment on a lot of plum seedlings

[44] KELLOGG, VERNON L. and DAVID STARR JORDAN, Scientific aspects of LUTHER BURBANK's work. A. M. Robertson, San Francisco, 1909.

[45] LUTHER BURBANK, his methods and discoveries and their application, by LUTHER BURBANK, edited by HENRY SMITH WILLIAMS. The Luther Burbank Press, New York and London, 3: 285-289, 1912.

that had been uprooted, which he placed in three piles — good, promising, and worthless — suggests the possibility of pre-judgment of fruit from observation of small seedlings. There are a good many characters of leaf and twig that are almost too intangible for description, like the changing expressions of the human face, or like delicately graded colors, yet which to the practical eye are full of meaning. . . . It may be expected that a plum or peach seedling having foliage of a reddish-purple color will produce fruit dark-colored not only in skin but in flesh. . . ."

SHULL, who collaborated with BURBANK for several years, and is perhaps better posted than anyone I know of to speak of his working habits, is inclined to discount most of the statements of visitors and even of BURBANK himself as to his ability to judge seedlings by means of correlative characters but it should be remembered that SHULL is a geneticist — an eminent one and a pure scientist — whose interests lie in the direction of discovering and formulating laws or other fundamental concepts of heredity, and therefore may be rated as a severe critic. He writes[46] "Regarding the ability of Mr. BURBANK to detect correlations between seedling characters and adult characters of flowers or fruits, my conclusion has been that although there is a basis for the story, the correlations involved are very general and not specific. Mr. BURBANK's own statement regarding the basis for his putative canniness in selecting in the seedling stage, was that if the seedling shows lush growth, thick stems, and fat smooth buds, the subsequent growth of such plant can be expected to give larger and better fruit than if the seedlings show a tendency to have thin, spindly stems, and narrow buds. The tales of wizardry that have been built on this general correlation were figments of the imagination — probably figments of Mr. BURBANK's own imagination, primarily, but also of the more or less imaginative reporters of his prowess."

In my contacts with scores of scientists — both pure and applied — in the course of these studies, I have found geneticists as a class to be the most critical of BURBANK's worth to society, but upon closer examination it develops that they always judge him by the same standards they apply to themselves. In other words, the first reaction of the pure geneticist to the question of a man's worth as a breeder of plants or animals is whether he has discovered new truths or advanced our knowledge in this field of endeavor, and not whether he has improved our living conditions in a social or economic way. He does not deny the need or desirability of having improved varieties and types of plants or animals for one purpose or another — not at all — he simply is not interested; his life's endeavor lies in another direction. The practical breeder, like BURBANK, is intent upon producing new things for some utilitarian purpose. Another geneticist,[47] who had visited

[46] Personal letter, November 11, 1939.

[47] JONES, D. F., BURBANK's results with plums. Journal of Heredity, August, 1928.—Life and work of LUTHER BURBANK. Spragg memorial lectures on plant breeding. (First series.) Department of Farm Crops, Michigan State College, East Lansing, Michigan, p. 57, 1937.

BURBANK, made some study of his work. A few of Dr. JONES' views are set forth below:

"BURBANK's incontrollable characteristic of over-statement, his uncritical attitude towards his own work and gross exaggeration of facts, together with misstatements and the ridiculous nonsense of HARWOOD, WICKSON, and other writers about his work, have naturally led to an over-critical attitude on the part of most geneticists and horticulturists as to the real merits of a man who was sincere in efforts, personally charming, and extraordinarily industrious."

Dr. JONES castigated BURBANK for claiming to have observed a case of what he called sap-hybridization. A scion from a purple-leafed plum was grafted on a green-leafed plum tree, and although the branch did not bloom, some of the seedlings from the tree itself showed colored leaves. "Although BURBANK had no doubts about this being a case of hereditary influence of the scion on the stock he can hardly expect all fruit growers to share his confidence."

He also denied the validity of BURBANK's claim to having demonstrated that teosinte was a primitive form of maize and had grave doubts that he had successfully hybridized corn and sorghum. And further, "his theory that hybrid vigor is an atavistic return to the vegetative luxuriance of plant growth in the Mesozoic era is a laughable instance of wild speculation that hardly helps to understand this phenomenon. Heredity that remains dormant for a million generations and then comes to light on crossing would be a far more remarkable event than the invigorating effects of hybridization itself."

BURBANK did like to philosophize. JONES thought that he had been greatly influenced when a boy by RALPH WALDO EMERSON's essays and caustically remarks that in his statements, "There is much more influence of the philosopher of Concord than the eager observer on the Beagle."

BAILEY, the botanist and prolific writer of horticultural books as well as treatises on plant physiology and plant breeding, envisioned the viewpoints and purposes of both the theoretical and applied breeder. Having visited BURBANK and made a study of his methods and accomplishments he has this to say about his ability to make successful selections from his multitude of seedlings:[48] " . . . . The judgment as to what will likely be good and what bad is the very core of plant-breeding. In this judgment BURBANK excels. Not to many men is given this gift of prophecy. BURBANK calls it intuition. He cannot explain it any more than another man can explain why he is a good judge of character in human beings. Long experience and close observation have directed and crystallized this faculty of his, until it is probably as unerring as such faculties can be."

Professor BAILEY's impressions of BURBANK's discernment are of particular value because he was not only a famous teacher of

[48] BAILEY, L. H., A maker of new fruits and flowers. World's Work 2:1209-1214, 1901.

his time (the eighties and nineties), but himself enjoyed a rather wide reputation as a keen observer and for his perspicacity in estimating values from external characteristics in both people and things that came under his notice. With this in mind, and for the further reason that BAILEY had an extensive personal acquaintance among plant breeders and was familiar with the literature of his day on evolution and breeding, it will be of interest to hear his general summation of BURBANK:[49] "LUTHER BURBANK is a breeder of plants by profession, and in this business he stands almost alone in this country. . . . So many and so striking have been the new plants that he has given to the world, that he has been called the 'wizard of horticulture.' This soubriquet has prejudiced many good people against his work. LUTHER BURBANK is not a wizard. He is an honest, straight-forward, careful, inquisitive, persistent man. He believes that causes produce results. His new plants are the result of downright, earnest, long-continued effort. He earns them. He has no other magic than that of patient inquiry, abiding enthusiasm, an unprejudiced mind, and a remarkably acute judgment of the merits and capabilities of plants.

"Personally, LUTHER BURBANK is rather small and spare of stature, somewhat stoop-shouldered. He is inclined to be slow of movement, but he is very quick of perception. He is an intent listener. He is inclined not to talk of his work, but to one who has a genuine interest in his experiments he talks freely and frankly, but never boastfully. He likes to dwell on his failures and the delight that the guest has given him. He shows you his plants, tells you how he produced them, then allows you to make your own judgments of their merits. You feel his kindly and gentle spirit, and before you know it you love him. . . ."

The foregoing paragraph suggests another thought: the great difficulty, if not impossibility, of discussing BURBANK objectively if the writer has known him intimately, or, sometimes, only casually. Many have testified to the magic of his personality. FAIRCHILD[50] almost complains of this as he tried to analyze the man after a two-day visit: "One might describe BURBANK as like TOLSTOI, in that, when one was with him, one felt the strange force of his simplicity and his profound confidence in his own abilities. But, on leaving him, the impression faded, and one began to wonder wherein lay his power, for his results did not quite seem to justify his claims."

Both BAILEY and FAIRCHILD are kindly men. The former is a poet as well as an interpreter of science, while the latter, although of the artistic type, endeavors to be more coldly analytical in his pronouncements. That is why he seems to have been somewhat annoyed at himself. A struggle of the head against the heart.

---

[49] *Ibid.*

[50] FAIRCHILD, DAVID, The world was my garden. C. Scribner's Sons, New York, 1938.

Now, it may be asked, after hearing all the evidence, what do I think of BURBANK as a scientist? My reply is that it depends upon the particular meaning we may give to the word. If we strip the several definitions down to bedrock and say that science is knowledge, and that a scientist is one who advances knowledge, then I should not hesitate to say that BURBANK qualifies for the mythical crown. His genius lay in the direction of demonstrating and proving old truths rather than discovering new ones. The fact of variation in plants was established by DARWIN and generally accepted. He also pointed out the how and the why of variation through cross pollination, and the possibilities of improvement through natural selection, but it remained for BURBANK, alone, undirected, and unaided, to demonstrate these truths on a scale so grand and complete that it has been the marvel of the age. The fact becomes even more noteworthy, because to BURBANK DARWIN's pronouncements were in the nature of theories. So far as I can determine, he was not familiar with the work of KNIGHT, SHIRREFF, NIELSON, VAN MONS, the VILMORINS, and other plant improvers in Europe. To BURBANK the corollary of variation and selection was the production of new types and varieties of plants that would be useful to man. During the first fifteen or twenty years of his breeding activities it probably never occurred to him to try to formulate laws of heredity. He was only interested in obtaining new and useful forms as quickly as possible by causing his plants to vary and then perfecting his technique of selection. I repeat that during this period little was known about rules and laws of inheritance of characters. European breeders were already groping in this direction but BURBANK was unaware of the trend.

After 1901 there was much ado about the recent rediscovery of MENDEL's classical experiments of a generation earlier and the laws of inheritance of characters that he laid down, but BURBANK was unimpressed. He took little stock in the new theory — disbelieved it, in fact, because he had been successful without knowing anything about it. And neither did he set much value on the mutation theory of DE VRIES. He preferred to stick to the principles of DARWIN. He cared nothing about laws; what he wanted was results. ". . . . To would-be plant experimenters who ask my opinion of matters connected with the old versus the new interpretations of heredity (Darwinian vs. Mendelian), I am accustomed to say:[51] 'Read DARWIN first, and gain a full comprehension of the meaning of Natural Selection. Then read the modern Mendelists in detail. But then — go back again to DARWIN'."

He then relates that[52] ". . . . just at the close of the nineteenth century, Professor HUGO DE VRIES came forward with his 'mutation theory', it had all the force of a new doctrine, and was even thought by some enthusiasts — though not by its originator — to

[51] LUTHER BURBANK, his methods and discoveries and their practical application, 2: 70-71.

[52] *Ibid.*, p. 90.

be in conflict with the chief Darwinian doctrines." He declares that DE VRIES never thought of his theory in any sense as contradicting the Darwinian theory of natural selection. On the contrary, it is to be regarded as supplementing and supporting that theory.

DE VRIES accounted for the occurrence of mutants in his primrose as being probably due to altered conditions of nutrition and thought that all species probably are subject to mutation periods.[53] "It was recognition of the difficulties thus presented, undoubtedly, that led Professor DE VRIES to devise the rather visionary hypothesis of *periods* of mutations. . . ."

"In a word," said BURBANK, "the varied tribes of evening primrose which Professor DE VRIES developed in his gardens at Amsterdam were overwhelmingly suggestive of various and sundry new forms of hybrid plants that I myself have developed year after year in my experimental gardens at Santa Rosa. . . . Over and over again, hundreds of times in the aggregate, I have selected mutants among my plants, and have developed from them new fixed races. But in the vast majority of cases I knew precisely how and why these mutants originated. They were hybrids; and they were mutants *because* they were hybrids. And so from the outset, I have believed that Professor DE VRIES' celebrated primroses had the same origin."

This was BURBANK's attitude at the turn of the century and despite the advent of Mendelism he continued to have faith in the Darwinian theory of plant evolution. But something happened about 1912 to make him appear inconsistent. At this time an organization known as the Luther Burbank Society was formed by promoters to exploit the life and writings of BURBANK. To this end a professional writer, HENRY SMITH WILLIAMS, was engaged to edit a twelve-volume set of books to be entitled "LUTHER BURBANK, His Methods and Discoveries and Their Practical Application", which was intended to be an autobiography. The scheme was an exceedingly ambitious one with many ramifications (Chapter VIII). BURBANK was supposed to do the writing. Actually he devoted two or three hours a day to dictating answers to questions that were propounded to him by the editorial staff headed by WILLIAMS. Supposedly the books were prepared from this material. There is much evidence to show that the editors took so many liberties with the statements, and put so many words in his mouth, that it is often difficult to tell who is speaking, BURBANK or the editor. I am well enough acquainted with BURBANK's style and idiom, from reading his catalogs, papers, and letters to feel that I can identify the true as well as the false, including subject matter, phrasing, facts, and manner of statement. It was the task of the editors, at the behest of the promoters — not BURBANK — to make him a world character as a scientist, and BURBANK fell in with the plan. By nature BURBANK was of a modest,

[53] *Ibid.*, p. 96.

retiring disposition; hated personal ostentation and display (such as heading parades and appearing before large audiences), and avoided the limelight where possible. He, however, thought highly of his own achievements, did not stint words when writing about them; desired commendation and approval; was highly susceptible to praise; allowed others to go as far as they liked in writing about him; so the stage was set for WILLIAMS and his cohorts to play him up to the public in accordance with their own ideas. This was a rare opportunity for a writer of WILLIAMS' skill. Even though BURBANK furnished him with tens of thousands of words — in answers to questions — the insatiable editor did not find this enough for his purposes. In discussing the scientific aspects of plant breeding he interpolated paragraphs and sometimes whole pages of his own ideas, palpably not BURBANK's. In the course of some of these perorations the editor became so enthusiastic in unfolding his ideas that he unconsciously stepped out of character and referred to BURBANK in the second person, whereas it was intended for the reader to believe that the books were written by BURBANK and that, at all times, he was the speaker.

For editorial reasons, then, BURBANK was made to discuss scientists and scientific theories that he knew little about — and I fear, cared little about — and to make statements he most likely would not have made of his own volition. The books were prepared for popular — yes, very popular — consumption so it was necessary to make them easy to read. The editor was proud of his ability to popularize science — in fact, he was no doubt hired because of success in that direction in the course of his career as a compiler of popular books. He was apparently a man who had read widely, much more so than BURBANK could have found the time to do had he had the inclination, so he knew the names in the scientific world both past and present as well as the patter, but his handling of BURBANK's career did not enhance the latter's reputation as a scientist. The BURBANK books prepared by WILLIAMS and his helpers did serve their major purpose no doubt — that is, to sell, or rather, to fulfill a pledge to the subscribers, in a doubtful membership scheme of the so-called Luther Burbank Society. The membership of the Society as a class consisted of worthy people who were wholly unlearned in science. For the most part they were nature and garden lovers who must have been fascinated with the beautiful stories of BURBANK's accomplishments. The most commonplace incidents in a gardener's life, such as budding and grafting, were made to appear marvelous.

Apparently BURBANK had been instructed to tell what he had done and how he did it, including the technique employed, to the end that each reader might take up the work of plant improvement where BURBANK left off and carry it forward to infinity. BURBANK was naïve enough to take the assignment in dead earnest. He believed that he was performing a service to humanity comparable to what he had accomplished in giving to the world a long

list of new fruits, flowers, and other useful plants. Of course, monetary profits would accrue, to the promoters at least; where BURBANK was to come in is not clear. But I am convinced it was not the money inducement that caused him to enter upon this herculean task. Justifiable pride was one factor, but the controlling motive I believe to have been that of Service. He is on record as saying, "My aim in this work is to benefit mankind. If I receive enough material returns to pay my expenses I am satisfied, for I feel there are so few who can improve our fruits that it is my duty to fulfill my plans."

With much prodding he went through with his part of the program but it was almost too much for his strength as he was at the same time trying to carry on his usual work of plant breeding. Whether he was pinched for funds to run his business I do not know. His income of $10,000 a year from the Carnegie Foundation had been cut off two or three years before but he had not yet begun to lose the income from his products by reason of his deal with the Luther Burbank Company which happened a year oı two later.

He probably profited very little from the schemes of the Luther Burbank Press and Society. Although they published the twelve-volume set of books[54] the promoters were not satisfied but immediately launched grandiose plans for special editions in translated form for six foreign countries, and after that at least six different editions ("with perhaps different kinds of bindings")[55] that would appeal to particular groups in this country. Finally they envisaged a line of textbooks for "schools and high schools, colleges, agricultural colleges . . . the general public all over the United States is actually hungry for the Burbank books, giving information upon these new plant-breeding methods . . ." (Chap. VIII). But about this time the over-distended bubble burst — the beautiful dream vanished — for the publishers, the Luther Burbank Press, were thrown into bankruptcy.

The Luther Burbank Society's books further helped to confirm BURBANK's widely spread reputation as a popular idol, but the number of persons that read them, relatively speaking, was not great, on account of their cost, which to the subscriber was $181 a set. The damage the books did to his reputation in scientific circles was incalculable as they helped to confirm previous opinions that he was, from the scientific viewpoint, a slipshod workman. The books related a host of dogmatic facts but failed to give essential information.

Another harmful effect of the books will go on and on because the matter contained in them will be used as the authoritive views of BURBANK. I concede that his various accomplishments are listed and described approximately as he gave them or would give them,

---

[54] LUTHER BURBANK, his methods and discoveries and their practical application.

[55] Santa Rosa Press-Democrat, Santa Rosa, California, October 9, 1912.

and sometimes in approximately his own words, but the opinions of the editors, masquerading as BURBANK, are both fatuous and uncalled for, misrepresent him and render him vulnerable to ridicule. Already at least three publications have appeared that are based on the WILLIAMS-written twelve-volume set. The first was gotten out by Mrs. BURBANK—an abridged eight-volume set which did no harm, except as it put more of the misleading statements into circulation, as no new material was introduced. Another publication, *The Harvest of the Years,* was by WILBUR HALL, who had the advantage of several months' association with Mr. BURBANK and got much of his material first-hand. Unfortunately this author's knowledge of horticulture and plant breeding was distinctly primitive, so while he used some of the ghost-written matter, he had BURBANK at hand to interpret for him and very wisely refrained from using matter which he, and perhaps BURBANK too, knew to be spurious. The book is mostly made up of human interest things pertaining to BURBANK's life. This is far and away the best biography of BURBANK that has ever been written. With the author's complete lack of technical knowledge of BURBANK's work, he still did him no harm but at the same time did not improve his reputation in the world of science.

The latest BURBANK book by the same author (assisted by Mrs. BURBANK?), *Partner of Nature*[56], is a compendium or rehash of the famous twelve-volume set, and of course unfortunately tends to perpetuate the failings of that publication.

On the whole, I believe BURBANK's reputation is improving with time. I base this belief on the fact that scientists now speak of him more sympathetically than they did when he was living. I have sought the views of scientists in every state in this country and find them not only tolerant but kindly. With few exceptions the old rancor is gone. Controversial and unimportant issues appear to have been forgotten. Only essentials remain—that he was a pioneer in plant improvement, regardless of the fact that he has been misrepresented by those who would make a popular hero of him; that his name was sullied by venal promoters; fair-minded people still accord him a place in the scientists' Valhalla for his accomplishments in the field of plant-breeding.

[56] D. Appleton-Century Company, New York, 1939.

VI

BURBANK THE EGOIST

WE LEARN from BURBANK, himself, that as a child he was distressingly bashful and so timid that he would not appear at mealtime if a stranger was present. Because of this affliction he was often in hot water at school. On certain days every pupil was required to stand up and speak a piece, something memorized for the purpose. LUTHER was too self-conscious to do this. His suffering was so obvious that a sympathetic teacher allowed him to write a weekly essay in lieu of declaiming.

A further childhood handicap was the possession of a frail body which kept him from participating in the more boisterous sports. Left much to himself he was given to introspection; his thoughts soared beyond his environment. He knew that he was better informed than other boys of his age—that he read more, and perhaps listened more intently to discussions among his elders. His father, a native son of Massachusetts, was a man of varied interests—farmer, brick manufacturer, contractor for supplying pulpwood to paper mills—and always kept posted on current events, the kind of man that others liked to parley with, and consequently had many visitors. LUTHER liked nothing better than to "sit up" of winter evenings before a blazing log fire and listen to discussions on a wide variety of subjects: history, literature, politics, religion. Every new idea or proposition, whether national or local in nature, was turned over and over in spirited debate. Political, and especially theological questions, were discussed endlessly, often with warmth.

When LUTHER was about ten years of age the burning topic of the day was theological, had to do with the heretical pronouncements of CHARLES DARWIN in his *Origin of Species*. "The intellectual world was in a ferment," reminisced BURBANK some fifty years later, "and nowhere was the influence of the new ideas more quickly felt or tumultuously argued than in New England." This is only a sample of the tides of talk that ebbed and flowed about the BURBANK table and fireside. Young LUTHER was precocious and undoubtedly had a good opinion of himself, but there seems to be no evidence that he was looked upon as a conceited youth. Self-confident, yes, but extreme pride of accomplishment, with its concomitant of vanity, bordering on arrogance, came much later. However, it should be stressed that at no time was he aggressive in his arrogance, never inclined, without provocation, to press his opinions upon others. In his contacts with home folks, in lodge, and town meetings, I have not heard of a single instance of his setting himself up as an authority on questions at issue, or trying, arbitrarily,

to dominate a situation. To be sure, he was good at informal, round-table debate; but knowing his aversion to standing up before an audience, for any purpose, I doubt if he ever had much to say. Still, in the meetings he attended and in small crowds or at home, he could joke, tell stories and be lively. In fact, outside of his profession, BURBANK was rather famous for his bonhomie, was a man's man, but on the subject of what, to him, was his sacred destiny, and his ability and right to carry the torch of leadership, he was a stone-wall of intolerance.

When BURBANK was about eighteen, in accordance with custom, he began to give considerable thought to his life work, to the profession he would like to follow. His state of health made farming seem too arduous. He tried employment in a wood-working factory but was soon incapacitated by the dust from his lathe. Entering Lancaster Academy, one of his courses of study was human physiology. This developed in him the ambition to become a physician, but he had to leave school and help in the support of his widowed mother. This brought him back to what probably was his first interest. He became a gardener, a grower of vegetables, for he had always loved plants. When he was twenty-three or twenty-four he drew a lucky number by developing a new potato. Other vegetables were hybridized with indifferent results but destiny was weaving the web that was to completely enmesh him after he had read what DARWIN had to say regarding the possibilities of modifying and improving plants through hybridization and selection. Plant improvement thus became the great ruling passion of his life. So sure was he that he could contribute untold benefits and values to the world that he looked upon his task as a foreordained mission, even envisioned himself as a Messiah. Unlike that other Messiah, the Jewish lad YESHUA, son of JOSEPH and MARY[57], who had required many years of prayer and meditation to decide whether he was the real Messiah—the one that had been promised by the prophets, —BURBANK was quite sure of his Messiahship almost from the beginning of his career in Santa Rosa.

As early as 1888 or 1889, he remarked to Dr. ANDERSON[58], of Santa Rosa, that the world had experienced many Christs—at least thirteen; that they assumed different forms and might continue to arise from time to time, and hinted that he, himself, he felt, was approaching that status. "This idea was only vaguely conveyed to me," said Dr. ANDERSON, "but to my mind, the implication was clear." He never elaborated on the theme and ANDERSON, being a very young man and an employee (he worked for BURBANK evenings, kept his accounts), refrained from asking questions. As a matter of fact, he was flabbergasted at the extraordinary statement. There was no doubt about it having been made in all seriousness and the situation was one that admitted of no argument.

---

[57] SHALOM ASCH, The Nazarene. G. P. Putnam's Sons, New York, 1939.
[58] Personal conversation with the author, June 9, 1938.

When not busy BURBANK was sometimes talkative, and at such times inclined to reveal his inner self. It was on one of these occasions, mentioned elsewhere, that he compared himself to NAPOLEON. He frequently exulted at his growing recognition as evidenced by orders or inquiries from foreign countries. His mission was being fulfilled. This mission, it should be made clear, had nothing to do with spiritual leadership. It was wholly material in the sense that he felt he was destined to bring happiness and prosperity to the world through his plant creations. By this terminology he did not intend it to be understood that he possessed miraculous powers of creation, but he did want the public to feel that he was a superior workman with plants and could accomplish things by his methods that others could not achieve. And to a considerable extent this feeling was justified in that he began in the late eighties to offer for sale such an array of new varieties of fruits and flowers as to astonish the horticultural world and bring wonderment to the uninformed public which knew nothing about such things. It is not surprising that his accomplishments tended to stir the popular imagination and that space writers should take advantage of the opportunity to flood the press with exaggerated reports of his doings. As a matter of fact, the principles he employed were prosaic enough and well known to botanists and professional horticulturists, that is, the process of crossing varieties — thus commingling their characters — then selecting from the resultant seedlings those that are different, or in some respects better, than their parents. But others were not doing this, at least not on a scale large enough to secure noteworthy results, so he was unique and stood alone in his field.

Partly through good fortune but mostly due to shrewdness he started with Japanese plums. As no one had given much attention to this interesting fruit, which had great possibilities, his results were astonishing and spectacular. Even his direct importations, which anyone might have made, were a success, and his later hybridizations still more so, but again, others with less daring or business acumen, due to the inhibitions of custom, or what not, had failed to see the opportunities and improve them.

The zeal of the Apostles in spreading the gospel among the Romans was scarcely greater than BURBANK's ardor in his mission as he thought he saw his dreams coming true. Just as PETER and PAUL expected to see the whole world evangelized in short order, so did BURBANK feel that he was on the way toward bringing material comforts to a grateful populace. He was never lacking in appreciation of his own good points and, with the success that attended his early ventures, it is small wonder that he quickly developed the belief that it was possible to revolutionize the appearance and uses of all the plants of the earth — that they could be moulded to any degree, according to will, to meet the needs and wants of mankind for food, raiment, building materials and esthetic values.

In addition to his own convictions he had strong allies in his mother and sister. The mother had always believed in her son and admired his ability. She was in no sense a visionary and therefore had some misgivings about his program, perhaps thought or feared that it was a bit impractical. Never having known fame or fortune her aspirations were on a reasonable level. She was sympathetic but practical, and while gifted with a lively imagination she never allowed it to run riot. But not so sister EMMA. She worshipped her brother and believed in everything that he did — believed that he could accomplish all the things he dreamed of. So she encouraged him in all his plans and aspirations. Being unacquainted with the technique of his work — knowing nothing of horticulture and its problems — she was never beset with doubts as to his greatness. She was anxious for honors to be heaped upon him; and while wealth was not to be despised, honors and acclaim were more desirable. In season and out of season she sang his praises, wrote about him, kept all clippings for his scrapbook, talked to space writers and would-be interviewers, sought to protect him and his valuable time when he would have been absorbed by a curious and hero-worshipping public. A true friend and disciple, devoid of ulterior motives, she never let him down. Incessantly she fed his natural ego and cultivated the Messiahship idea. I have wondered that she did not revive the ancient order of *illuminati*, a sect whose members professed to have extraordinary knowledge or gifts, for he filled the bill perfectly.

Besides the members of his family — mother, sister, brothers — BURBANK had many personal friends who were devoted to him and believed in his infallibility. Judge LIEB of San Jose, California, was a typical example. The Judge was a follower but did not become a real disciple until BURBANK gave him a "sign", by successfully prejudging a batch of seedling fruit trees. Thereafter he had no doubts and was ready and willing to render full homage to his leader. LIEB's friendship was not only sincere, it was altruistic. Also he lived in the country, was a fruit grower and therefore possessed a technical knowledge of horticulture.

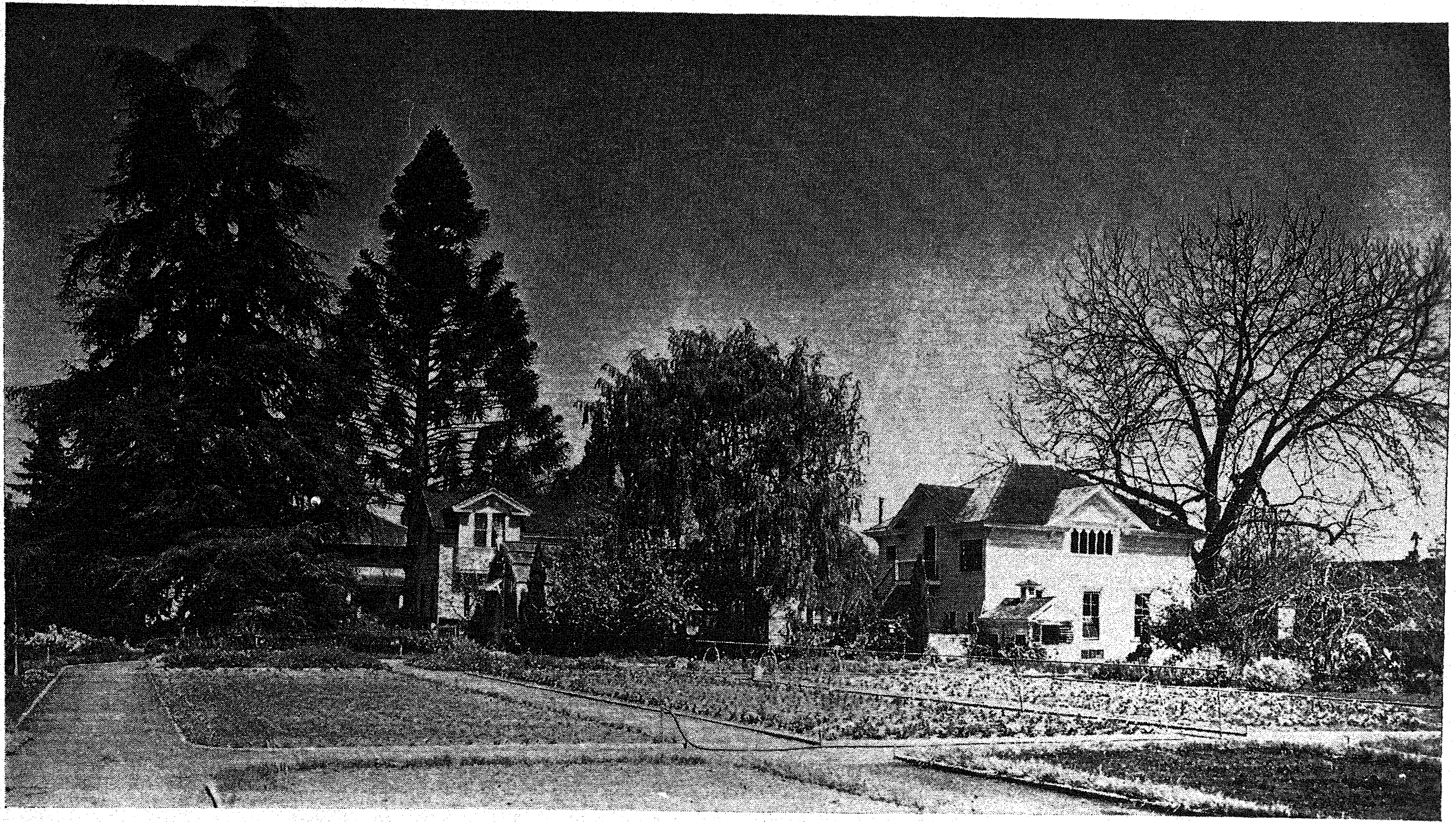
There were numerous other admirers who fall into various categories. Some were well-meaning but completely ignorant of his technology. Many were parlor naturalists and lovers of the wonderful in nature. There were garden enthusiasts and sentimental folk who wanted to do honor to the great, and they were all industrious in their acclaim of their idol. And, finally, there were the news writers and the dealers in BURBANK products whose accolades and paeans of praise were not without self-interest. Both of these groups were masters of publicity. Once as a matter of curiosity I asked a prominent editor and local correspondent of city papers, who as a young man had publicised BURBANK's doings, why he was such a great admirer of BURBANK. Since I knew them to be personal friends I expected him to enlarge upon the beauties of the man's character and the like but, without hesitation, he

replied, "Why I don't believe I ever called upon him that he did not give me a good story for my paper. He was certainly a wonderful man. Never was one like him before," and then launched into a denunciation of those who would minimize his genius and the institutions that failed to endorse and support him.

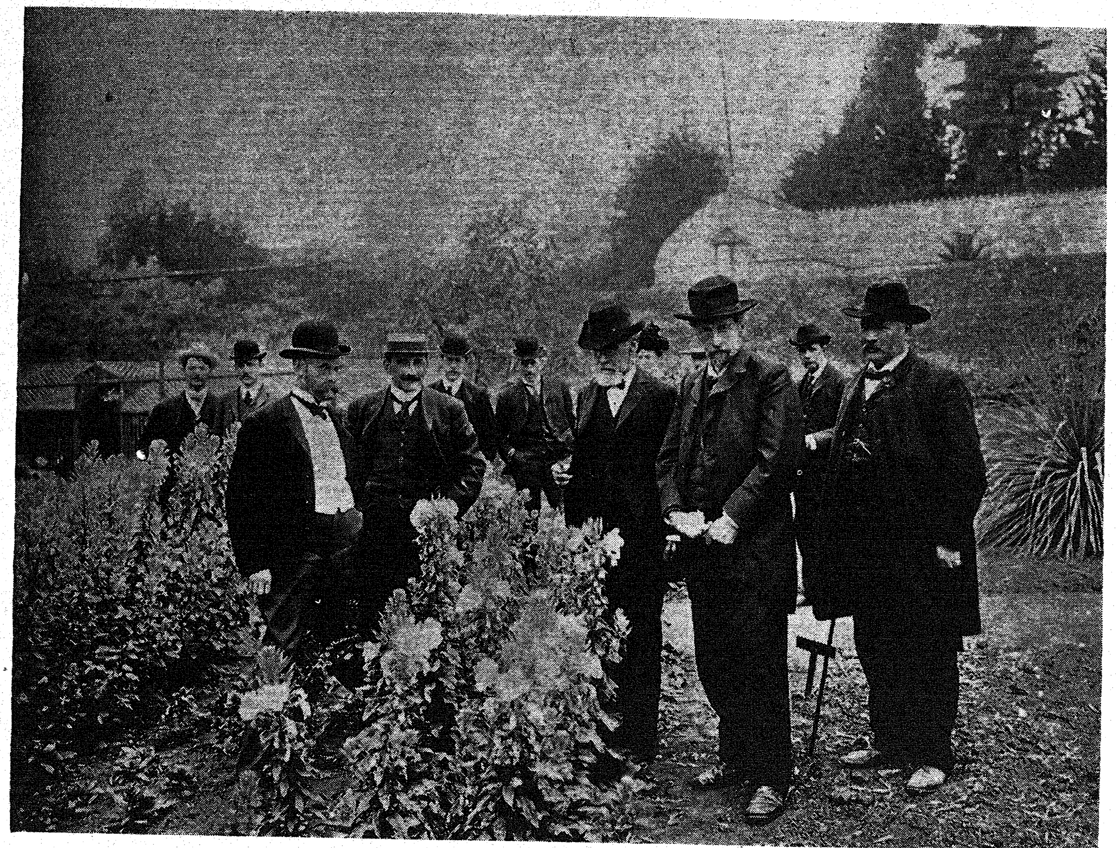
As to BURBANK's attitude toward the extravagant praise he received, he was something of a paradox. As stated elsewhere, he was personally modest and wanted to believe all the good things that were said about him. He believed them in the abstract, so to speak, but shrank from coming into personal contact with them. That is, he didn't mind being worshipped and reverenced at a distance but sought to dodge responsibility, in a measure, by refusing where possible to appear before crowds of people either in a public or a private capacity. Part of this reluctance to appear before crowds was due to a natural shyness. He knew that he was a famous man, and worthy of his fame, but he seemed to fear that he might not make good as a public performer. He might have had feelings of inferiority about his culture but certainly not on his attainments.

It cannot be said too often that he believed in himself and his mission. In his early middle life — say from about 1895 to 1905 or a little later — with all his ego I do not believe he would have permitted his counsellors to have used him as a stalking-horse to try to discredit the rediscoveries of Mendelism, by attempting to show that he, himself, independently, had discovered and demonstrated the laws of heredity as laid down by MENDEL before the announcements of CORRENS, DE VRIES and TSCHERMAK. After all, I believe he was honest and believed in a certain fitness of things. He didn't feel the need of being hoisted to fame in this way and besides he was no believer in Mendelism. But then, during the period mentioned, he had not yet fallen into the clutches of mendacious promoters who were determined to make their own kind of hero out of him. (See Chapter VIII).

By 1912 he was, for him, living in a totally new era, an era of big business but I am certain that he did not profit much, if any, by the schemes that revolved about him. All his life before, he had held to the theory of doing good for his fellow man and was not ambitious for great profit. I think, primarily, that he allowed himself to be drawn into the Luther Burbank Press and the Luther Burbank Society schemes for the publication of a popular history of his life work because the promised publicity pleased his ego and the information that he could make available would be of use to the world (for was he not to do the writing himself?). But he was now much older and a very tired and much harassed man, and there is no evidence to show that he resented the liberties the editors of the books took with what he had written and especially with the words that they put in his mouth. Before he was through with the task of dictating he was driven to the verge of nervous breakdown, and he was doubtless too tired to know or care what they



Rear view of the old home of LUTHER BURBANK in Santa Rosa, California, where he resided with his mother for nearly thirty years. At his own request he was buried beneath the sweeping branches of the beautiful Cedar of Lebanon tree at the left. His office was in a large room (now called the "Studio"), over the garage at the right, originally a stable for his horse. The tree at the extreme right is a Paradox hybrid walnut, a cross between the cultivated Persian or English walnut, *Juglans regia*, and the Northern California black walnut, *J. californica* var. *Hindsii*. (*Photograph by* MR. ARTHUR E. GILMORE.)



Visitors in the Botanic Garden of the University of California at Berkeley, summer of 1904. Front row, right to left: Professor SVANTE ARRHENIUS, a Swedish chemist from the University of Stockholm; Professor HUGO DE VRIES, Dutch botanist from the University of Amsterdam, Holland; Dr. E. W. HILGARD, Dean of the College of Agriculture and Director of the Agricultural Experiment Station, University of California; Dr. JACQUES LOEB, Professor of Physiology, and E. J. WICKSON, Professor of Horticulture, both from the University of California. (*Courtesy of* MISS LESLEY C. WALKER, Oakland, California. Photographer unknown.)

made him say. This, combined with his disappointing experience with the Luther Burbank Company, marked the beginning of a distinct let-down in his ideals. (See Chapter XIII).

While he had been led astray from his life purpose and while his moral fibre had been weakened, his ego still survived and it may be that he derived a certain amount of vicarious pleasure in being compared to a man of the scientific stature of GREGOR MENDEL as well as the lesser luminaries, CORRENS, DE VRIES, and TSCHERMAK.

Secretly I don't think he was proud of the set of books which he had been led through Gethsemane to produce, as he was well aware of the questionable manner in which they had been financed and disseminated, but they did extend his fame to a certain audience to whom the contents were gospel; and they will remain as interesting documents for the wonderment of another age. The facts are that the books with all their beautiful color-photographs were almost ignored by the press. Here and there they were ridiculed on account of the shams practiced by the publishers in setting up a dummy Society to "help" in their production. I have scarcely seen anything in print about the books themselves.

While deep-seated and positive, BURBANK's egotism was not of the kind that grates on people. A man of firm convictions regarding his work and particularly his own values, he, nevertheless, could not be branded as arrogant or blatant. On occasion he could even be humble, but humility, I fear, was something of a pose. Toward casual visitors he was apt to be blunt in manner and dogmatic in statement, perhaps a cultivated mannerism designed to freeze them out and save his time. Toward his obvious worshipers he adopted a lofty attitude, was also dogmatic; and they loved it. In the presence of those whose good will he valued, he could be urbane, but even then he preferred to do most of the talking. To these, if they were known writers, he might stress his altruistic motives. But to all he appeared to assume that they came as votaries to the fountain of wisdom and that it was his duty to give and theirs to receive. His conviction was strong that he was a chosen one to do good in the world; then why shouldn't he have a good opinion of himself? Strangely enough, due to his personality, his air of confidence, his hearers were little disposed to challenge his statements or resent his vanities. On the whole, he might be rated as ego-altruistic, rather than egocentric.

VII

BURBANK THE MENTOR OF YOUTH

ALL his life BURBANK was a stanch friend of children, and, like many childless persons, held pronounced views on their bringing up, not in a disciplinary way, but for the good of their minds and bodies. As a first requisite he decreed that all children should be reared in the country, or at least under rural surroundings where they could have plenty of fresh, pure air and grassy playgrounds on which to romp and play. He considered it to be a short-sighted policy, if not criminal, to send very young children to school. He was certain that they should not be imprisoned in a schoolroom before they were ten years of age. They might even be older.

BURBANK's life was singularly free from the petty vices which society has come to accept in great or less degree, so he was a jewel of consistency and possessed no taint of hypocrisy when he preached to the youth of the land that they abstain from using tobacco or alcoholic drinks. He was particularly rabid against the use of tobacco; would not tolerate an employee who used it in any form; and once published a scathing article on the subject under the title "Tobacco, Tombstones and Profits"[59] in which he castigated the tobacco companies for undermining the health of a people for monetary profit. "Let me tell how tobacco kills," said he. "Smokers do not all drop dead around the cigar lighters in tobacco stores. They go away, and years later, die of something else. From the tobacco trust's point of view, that is one of the finest things about tobacco. The victims do not die on the premises, even when sold the worst cigars; they go away, and when they die, the doctors certify that they died of something else — pneumonia, heart disease, typhoid fever, or what not. In other words, tobacco kills indirectly and escapes the blame." He then continues in ironical vein, "I never met a tobacco user who did not regret that he had formed the habit, but I never met a non-smoker who was sorry he did not smoke. Isn't that significant? If tobacco is such a fine thing, why don't its victims rejoice? . . . Tobacco is a poison that would not be urged upon you if there were not a profit for others in making you a victim . . . . Youth is the dangerous age, as far as tobacco is concerned. If one can reach the age of twenty-five without smoking, the tobacco trust will have a hard time in getting him."

This was a favorite topic of his at teachers' meetings and at schools when he could be induced to talk. Because of his special

[59] Dearborn Independent, Dearborn, Michigan, July 21, 1923.

solicitude for the welfare of children, he rated tobacco as being a greater evil than liquor. This was during the early part of the prohibition era when he fondly believed that whiskey, in particular, was on its way out. Under other conditions — if he had not been wedded to his plant work — he might have become a militant reformer.

The biggest thing he did for youth was to launch a vigorous program for child and race improvement, by publishing an article entitled "The Training of the Human Plant",[60] which was later reprinted in pamphlet form[61]. While the ideas are his, the story bears evidence of having been ghost-written although some of the language is undoubtedly BURBANK's. Another version appeared about 1913 in Volume 12 of the LUTHER BURBANK series of books published by the Luther Burbank Press. Here the subject matter is overhauled and restated in the words of the editor, and, of course, BURBANK is made to discuss scientific findings in the field of eugenics which he probably was unfamiliar with.

In the original version of *Training of the Human Plant* the author says, "During the course of many years of investigation into the plant life of the world, creating new forms, modifying old ones, adapting others to new conditions, and blending still others, I have constantly been impressed with the similarity between the organization and development of plant and human life . . . . I have come to find in the crossing of species and in selection, wisely directed, a great and powerful instrument for the transformation of the vegetable kingdom along lines that lead constantly upward . . . . Upon it wisely directed and accompanied by a rigid selection of the best as well as rigid exclusion of the poorest, rests the hope of all progress. The mere crossing of species, unaccompanied by selection, wise supervision, intelligent care, and the utmost patience, is not likely to result in marked good, and may result in vast harm. Unorganized effort is often most vicious in its tendencies . . . .

"But when two different plants have been crossed, that is only the beginning. It is only one step, however important; the next great work lies beyond — the care, the nurture, the influence and surroundings, selection, the separation of the best from the poorest, all of which are embraced in the words I have used — selective environment . . . .

"We are more crossed than any other nation in the history of the world, and hence we meet the same results that are always seen in a much-crossed race of plants: all the worst as well as all the best qualities of each are brought out in their fullest intensities. Right here is where selective environment counts. When all the necessary crossing has been done, then comes the work of elimination, the work of refining, until we shall get an ultimate product that should be the finest race ever known. The best characteristics

[60] Century Magazine, May, 1906.
[61] Training of the Human Plant. The Century Company, New York, 1907.

of the many peoples that make up this nation will show in the composite: the finished product will be the race of the future. . . .

"In the immediate future, possibly within your life and mine, unquestionably within this generation, what we have most to fear . . . . is the children . . . . when they have grown and been trained to responsible age in vice and crime. We must begin now, today, the work of training these children . . . ."

He maintained that we must cut loose from all precedent and begin to give state and national aid in training the children of the poor and underprivileged in order that the integrity of the State may be maintained. "Rightly cultivated," he continues, "these children may be made a blessing to the race; trained in the wrong way, or neglected entirely, they will become a curse to the State. There is not a single desirable attribute which, lacking in a plant, may not be bred into it. Choose what improvement you wish in a flower, a fruit, or a tree, and by crossing, selection, cultivation, and persistence you can fix this desirable trait irrevocably. Pick out any trait you want in your child, granted that he is a normal child — be it honesty, fairness, purity, lovableness, industry, thrift, what not. By surrounding this child with sunshine from the sky and your own heart, by giving the closest communion with nature, by feeding this child well-balanced, nutritious food, by giving it all that is implied in healthful environmental influences, and by doing all in love, you can thus cultivate in the child and fix there for all its life all of these traits . . . . heredity will make itself felt first, and, as with the plant under improvement, there will be certain strong tendencies to reversion to former ancestral traits; but, in the main, with the normal child, you can give him all these traits by patiently, persistently, guiding him in these early formative years . . . .

"But, someone asks, what will you do with those who are abnormal? First, I must repeat that the end will not be reached at a bound. It will take years, centuries perhaps, to erect on this great foundation we have in America the structure which I believe is to be built. So we must begin today . . . . Shall we, as some have advocated, even from Spartan days, hold that weaklings should be destroyed? No. In cultivating plant life, while we destroy much that is unfit we are constantly on the lookout for what has been called the abnormal, that which springs apart in new lines . . . . No; it is the influence of cultivation, of selection, of surroundings, of environment, that makes the change from the abnormal to the normal. From the children we are led to call abnormal may come, under wise cultivation and training, splendid normal natures . . . .

"In child-rearing, environment is equally essential with heredity. Mind you, I do not say that heredity is of no consequence. It is the great factor, and often makes environment almost powerless . . . . environment [alone] will have a hard battle to effect a change in the child . . . . repeated application of modifying forces in succeeding generations will at last accomplish the desired object in the child as in the plant . . . .

"It would, if possible, be best absolutely to prohibit . . . . the marriage of the physically, mentally, and morally unfit . . . . first cousin marriages when they have been reared under similar environment should, no doubt, be prohibited."

He declared that there never has been such a thing as a predestined child, predestined for heaven or hell, although men have taught such things, and that total depravity never existed in a human being any more than it could exist in a plant.

"My own studies," said he, "have led me to be assured that heredity is only the sum of all past environment . . . . and I am assured of another fact; acquired characters *are* transmitted and — even further — that *all* characters which *are* transmitted have been acquired, not necessarily at once in a dynamic or visible form, but as an increasing latent force ready to appear as a tangible character when by long-continued natural or artificial repetition and specific tendency has become inherent, inbred, or 'fixed' as we call it . . . . Repetition is the best means of impressing any one point on the human understanding; it is also the means which we employ to train animals to do as we wish . . . . By repetition we fix any tendency, and the more times any unusual environment is repeated the more indelibly will the resultant tendencies be fixed in plant, animal, or man, until, if repeated often enough in any certain direction, the habits become so fixed and inherent in heredity that it will require many repetitions of an opposing nature to affect them."

The foregoing is a summary of BURBANK's philosophy of child improvement and race betterment. Idyllic and idealistic, a socialistic dream, but with human appeal, it is small wonder that the program received the endorsement of the pulpit and of humanistic writers. Some heralded it as the solution of the crime problem. The science of eugenics in 1906 had made little progress, birth control was not publicly advocated, and there had been no legislation designed to prevent the propagation of the unfit. However, about this time a forward-looking doctor,[62] only a few miles from Santa Rosa, began a daring experiment in eugenics which was destined to attract the attention and admiration of biologists and eugenist-minded people everywhere. People had talked about the advisability of curtailing the birth rate of undesirables but, for one reason or another, nothing much was being done in this direction until the physician in charge of the Sonoma State Home for the Feebleminded saw his opportunity. Among the inmates were many young women who had been committed to the institution for minor delinquencies and were to be held until they were deemed worthy of parole or discharge. For the most part these women — many of them young girls — were what is known as "incorrigibles," — that is, could not be managed by their parents or guardians.

---

[62] **BUTLER, Dr. F. O., Medical Director and Superintendent of the Sonoma State Home for the Feebleminded, Eldridge, California.**

While the Sonoma Home is primarily a refuge for the feebleminded, both male and female, it is not the policy of the courts to commit persons to the institution simply because they are feebleminded, but only when they have become delinquent and the delinquency can be attributed to their mental handicap. All the inmates then may be classed definitely as sub-normal, the upper level being moronic and the lower approaching the outposts of imbecility. True idiots and the insane are supposed to be sent to one of the State Hospitals.

Men and women are committed to the Home for a variety of reasons but the majority would fall under the general headings of petty thievery, alcoholism, and sex offenses. Case history studies show much bad blood in their ancestries ranging all the way from epilepsy, criminality and insanity to downright degeneracy.

Clearly such people should not be permitted to propagate their kind to become a burden on society. To accomplish this end, there seemed to be only two possibilities: permanent confinement at state expense, or sterilization and release on parole. The latter plan was adopted and proved to be very successful. While the state law permitted sterilization of the feebleminded — forcibly if necessary — the policy has always been followed by the state institutions of securing, where possible, the written consent of the nearest relative as well as that of the patient. At first the women were reluctant to submit to the operation, even when assured that they would not be unfitted for marriage (except that they could never bear children), so the wily doctor had to resort to strategy to make his program effective. He contrived to have a few individuals sterilized and released, saw them married, and then arranged to have them re-visit the Home and tell their sisters how they had found happiness. Men were even more difficult than women to convert to the new eugenic measure, although in their case the operation was a very minor one, but by 1918 the coöperation of both groups was obtained and by 1940 a total of over 3,700 sterilizations had been performed,[63] a majority of them women. The success of the venture has inspired similar programs to be instituted elsewhere in this and other countries.

While BURBANK's paper had nothing to do with starting the Sonoma Home experiment, it is reasonable to suppose that it was made easier by reason of his having convinced many persons of the need for curtailing the propagation of the unfit, who otherwise, through sentiment, might have opposed the program.

At the time BURBANK published his paper on child improvement he possessed a powerful hold on the imagination of the reading public, who believed him to be a man of rare ability and accomplishment and therefore was ready to accept any theories he might advance for the betterment of the race. As has been seen, the burden of his argument was that plants could be improved by methods he had perfected and he was positive that the same prin-

[63] Personal letter from Dr. BUTLER, April 30, 1940.

ciples would apply to children. And there was enough truth in the examples he cited of the favorable effects of environmental conditions on both plants and humans to incline the readers — who had complete faith in him — to believe everything he said. He was a popular idol for everything that was good and uplifting. His audience, for the most part, consisted of these good people who are hard to reach through the cold facts of science. But they were willing to listen to BURBANK, and thus the way was smoothed — at least indirectly — for a radical experiment in race betterment that might otherwise have been frustrated before it really got started by well-meaning but obtuse sentimentalists.

When BURBANK espoused a cause he did so in deadly earnest. He believed in himself, and when he had ideas on a subject they were apt to be of a positive nature. He was never namby-pamby or wishy-washy. When he talked about race inprovement he meant improvement on a grand scale. To him it was sufficient to point the way to reforms; others might devise plans for carrying them out, for he never presented a specific plan of his own. The nearest he came to doing so is a statement attributed to him in Volume XII of *Luther Burbank, His Methods and Discoveries and their Practical Application*, page 216, where he purports to say, "We shall attempt no details of suggestion. It suffices to point out the principle and to suggest that there cannot well be two opinions as to the desirability of restricting the fecundity of the unfit, however wide the diversity of opinion as to the way in which this may be practically accomplished." Whether he or the editors wrote this it is impossible to say. With the Sonoma Home developments at his very door he might very well have hinted at sterilization of the unfit as being one answer to the problem — indeed, may so have expressed himself to the editors — as it is my understanding that he had to give his approval to all that was written before it was finally published.

BURBANK had a good general idea of the meaning of heredity — "the occurrence, in organisms, of qualities, expressed or latent, derived from their ancestors"[64] as applied to plants, but having no knowledge whatever of chromosomes and genes and their significance — at least in 1906 — he was inclined to underrate its importance and immutability and to overrate the forces of environment. This was especially true when, in his imagination, he applied the principles of breeding he was familiar with to the improvement of human-kind. It is probable that the human animal is comparable to plants only insofar as physical attributes are concerned. When psychic or mental traits are taken into consideration the comparison tends to break down. In other words, as a theoretical breeding problem, the improvement of people is much more complicated than is the improvement of plants.

BURBANK knew something about dominant and recessive characters, although he did not himself employ this terminology, and

---

[64] Journal of Heredity, February, 1937.

the futility of trying to fix too many characters in a hybrid as a single objective; but he seemed to ignore all this experience with plants when he began to expound his theories about the betterment of people. Others had visualized an ideal state of society where there was no crime or immorality and no need of laws as described by PLATO over two thousand years ago, but BURBANK had the assurance to propose a plan for its realization here and now, but, unlike PLATO in his *Republic*, he did not face realities and go into details. It was just another dream by a man of spotless character, who loved children and his fellow-men and wished there might be a more perfect race to occupy a most beautiful world.

While sometimes naïve in his dealings with people he was not artless enough to really believe that his thesis for human betterment would be authoritatively adopted. He doubtless launched his thoughts as a sort of prayer that would give people something to think about. And it did. A certain part of the press commented favorably on the paper — some enthusiastically. They spoke of it as "suggestive" and "inspiring." It was well received by public school teachers and the clergy. Many personal letters were received commending him as a "student of life and philosophy of living things" and for his "interpretation of true heredity." [65]

The paper was an academic discussion of how the effects of bad ancestry, that is, heredity, may be ameliorated or completely overcome in human beings as well as in plants and domestic animals providing the child is taken in hand when still an infant. Whatever its merits as a scientific or social document, it enjoyed a rather wide circulation and, one way or another, received much favorable comment; and it is my belief that it served a distinct eugenic purpose by paving the way for Doctor BUTLER to carry out his famous program of "sterilization for human betterment" at the Sonoma State Home for the Feebleminded at a time when similar programs in other states had been stopped, by bringing pressure to bear on the Governor to veto the measure making it legally possible, as in Pennsylvania; by holding up appropriations to state institutions that permitted it, as in Indiana; or by stirring up adverse public opinion as in Washington, Oregon, New York, and other places. It appears to me that BURBANK had potent influence in stilling this opposition by his academic appeal for race improvement. The very fact that he did not enter into a discussion of ways and means of carrying out the program, and stir up controversy over details, was the secret of his influence.

[65] Testimonials published in his catalogs of 1919, 1921, 1923, 1924, 1925 and 1926.

VIII

BURBANK THE UNFORTUNATE

A FULL understanding of the events to be narrated in this chapter is all-important if BURBANK is to be fairly judged. I have, therefore, felt justified in going into them in some detail. Shortly after the turn of the century BURBANK's fame began to attract the attention of promoters. He was particularly vulnerable to their siren songs because he was finding it increasingly difficult to spare the time from his experimental work to market his productions. And they had to be sold to keep the business going. This was the situation that promoters took advantage of. Within a period of three years, 1912-1915, he had the misfortune to have his name associated with two gigantic enterprises that failed disastrously, and he barely escaped entanglement with another.

The two concerns that failed were the Luther Burbank Press, a book publishing business, and the Luther Burbank Company, which was organized to sell BURBANK's plant products. Both engaged in farflung activities. Their contacts numbered well over a million people and when they collapsed BURBANK's reputation suffered greatly because the public believed, on account of the names they bore, that they were his creatures.

As a matter of fact, and in all fairness, it should be understood that he was culpable only insofar as he had lent his name to the enterprises. Apparently, he owned no stock in either of them and had no part in their management, except that, in the case of the Company, he reserved the right to veto the appointment of members of the board of directors who did not meet his approval. In the book publishing scheme, he did dictate the material on which the volumes were based but the twelve volumes were actually written by high-powered editors employed by the concern for the purpose. He may have received a part of the flat sum promised him for his factual contributions and something on royalties, but he had absolutely nothing to do with soliciting subscriptions or selling stock in the Burbank Press.

Likewise he had nothing to do with the stock selling or merchandizing methods of either of the corporations, but in the popular mind he was, and is, held accountable for every statement made in their dealings with their tens — perhaps hundreds — of thousands of customers. One purpose of this book is to rescue his name and reputation from the obloquy suffered through his remote connection with the two enterprises.

The first scheme that was launched, the one that did not mature, was in 1909. Two men from San Francisco, HERBERT and

HARTLAND LAW, who had made a fortune in patent medicines,[66] together with OSCAR BINNER, a professional promoter, induced him to sign a contract agreeing to let them market everything he produced. A sales manager [67] was engaged and entered upon his duties at the BURBANK place in Santa Rosa. At the end of three months, while a corporation known as the "Luther Burbank Products, Inc." was being perfected, BURBANK suddenly decided that he didn't like to have other men around him with authority to give orders and so refused to go through with the plans. He stated in explanation,[68] "As no corporation has yet been formed and only a preliminary contract executed, when the proposition was found to be impracticable, it was mutually agreed that it be abandoned" and a representative of the company, Mr. BINNER, added the further statement: "For myself and my associates, the LAW Brothers, let me say that Mr. BURBANK's absolute happiness and contentment are our first consideration. . . . We were willing to step aside and annul the contract we entered into together on the 23rd of February." BURBANK agreed to keep the unlucky sales manager in his employ till he could find another job. So the incident was closed.

Three years later a representative of the Cree Publishing Company [69] of Minneapolis, Minnesota, organized the Luther Burbank Press with ROBERT JOHN as president of the firm. The aim of the enterprise was to exploit the BURBANK name by publishing a monumental history of the man and his work, to be written by BURBANK himself, with Rev. Dr. MAYO MARTIN as Editor. With a battery of helpers, MARTIN set up shop in the old BURBANK cottage while the BURBANK family moved to a new residence across the street. The editor struggled with the job for five or six years but progress was unsatisfactory. Apparently there was a reorganization, JOHN WHITSON replacing the Cree Publishing Company. The new firm was called the Luther Burbank Press. Preparation of a BURBANK history was still the big idea.

The promoters were men of lively imagination. From the beginning everything was planned on a grand scale. The essential advertising of BURBANK had already been done, for he had been publicized as few men have been during their lifetime. He had a legion of followers whose admiration was based on sentiment, and his name already was becoming a legend. The time seemed to be ripe for cashing-in on his popularity.

---

[66] Pacific Rural Press, San Francisco, California, March 6, 1909 " . . . . The brothers LAW are princes at publicity promotion. They made their wealth according to popular report by handling proprietary medicinal preparations in novel and effective ways, and such business has almost become a synonym for successful advertising and other promotive pushing among patrons who are disposed to enjoy high claims and content to verify them in their personal experiences. . . . "

[67] W. B. CLARKE, now a nurseryman at San Jose, California.

[68] Santa Rosa Press-Democrat, Santa Rosa, California, March 26, 1909.

[69] Santa Rosa Press-Democrat, January 10, February 21 and 23, 1907. DUGAL CREE, President of the Cree Publishing Company, arranged with BURBANK in September, 1908, for the publication of a 10-volume work to be entitled, "New Creations".

It is doubtful if BURBANK undertook the job wholly for profit. He had not previously shown a craving for wealth at the expense of sacrificing much of his professional career, for it cannot be emphasized too often that he sincerely felt called upon to perform a great work, a vital service to humanity. His mission was to breed more and more plant forms that were to be better and more useful than their predecessors. As a one-man institution, he had constantly to fight for time to do those things that he would entrust to no one else. This was the reason that he so nearly succumbed to the sales talk of the LAW Brothers and OSCAR BINNER three years earlier. Still he was willing to go on with the rejuvenated publishing scheme in spite of the time it would take. Presumably the old contract was yet in effect and had to be fulfilled or he may have had other reasons. (See Chapter XIII).

Apparently he was to have been paid $30,000 in cash and a royalty on books sold. However, his money reward was disappointing, a small down payment being about all he, personally, ever received. He retained possession of the copyright on the set of books and profited to some extent through issuing an abridged edition and finally, in 1939, long after his death his estate allowed the material to be boiled down to a single volume.[70]

The management of the Burbank Press[71] concocted a shrewd scheme for capitalizing the BURBANK name, at once obtaining a personal following, and laying the groundwork for selling their securities. They organized, or rather proclaimed, the existence of a so-called Luther Burbank Society,[72] and declared the membership was to be limited to 500 names, with the first hundred to be designated as charter members.

I, myself, as a young instructor in horticulture at the University of Missouri, received one of these invitations to become a charter member at a cost of one dollar. In return the publishers agreed to send proofsheets of the forthcoming book, "LUTHER BURBANK, His Methods and Discoveries and Their Practical Application," which they would ask the members to criticize and help edit. There were to be ten volumes and as rapidly as they were published they were to be sent to the distinguished list of subscribers who agreed to pay for them at a cost of fifteen dollars each — a total outlay of $151 including the membership fee.

My own invitation stressed the importance of quick acceptance as it was pointed out that only a few of the most important people of the United States were being invited and that I had the honor of being one of the number. To emphasize this point the invitations bore serial numbers. Mine was somewhere in the seventies. With the feeling that an obscure instructor had been mis-catalogued, I

[70] Partner of Nature. Edited and transcribed by WILBUR HALL, D. Appleton-Century Company, New York, 1939.

[71] Incorporated under the laws of the State of Maine on May 23, 1912. Charter to do business in California forfeited for non-payment of taxes on March 12, 1916.

[72] Incorporated April 3, 1912. Document on file in the office of the County Clerk of Sonoma County, California, in Santa Rosa.

dropped the invitation in the waste basket. In a month or two a second invitation came along, this time bearing a much lower number — thirty-five or forty or thereabouts. This went the way of the first.

About this time many of BURBANK's friends were becoming more and more apprehensive of the way his name was being exploited, as one of them stated, "to the point where the substantial reputation gained by his worthy achievements is being rapidly lost through the unworthy methods employed by organizations either affiliated with Mr. BURBANK himself or using his name with authority. . . . There is more than a suspicion that he has been exploited to his detriment by some of those he has trusted . . . ." Many schemes had been launched for selling spineless cactus, some with authority and some without. At best, extravagant claims were made but unauthorized wild-catters, aided and abetted by irresponsible space writers, suggested and even promised absurd and impossible things. BURBANK protested, ineffectually, through the medium of his own publications — catalogs and price lists — but the current of misstatement was too strong for him to struggle against. It may be that he recognized that he, himself, had set the pace.

A characteristic of BURBANK was that he did not bestow his confidence easily, but once a person could break through his protecting shell of self-sufficiency by making the proper appeal to his ego or cupidity, he seemed to accept that person and trust him implicitly. To trust a person, with him, was to ignore all criticism as he ignored it toward himself. Not given to seeking advice, he was apt to be suspicious of those who tendered it. While gratefully accepting the plaudits of his admirers, he had found by experience that they could go too far and subject him to ridicule. Therefore, he was inclined to be mistrustful of many of his would-be friends.

I have no evidence that BURBANK gave any serious thought or attention to the doings of the Luther Burbank Press or its spawn, the so-called Luther Burbank Society. He must have been cognizant of the methods being employed but he was absorbed in his own affairs and chose to ignore them, as he did on other occasions, thus employing a sort of split personality, although in general I would not class him as a schizophrenic, for that is too near dementia; and he certainly was not mentally unbalanced.

The agricultural press of California was friendly toward BURBANK and believed in him but in 1913 editors began to speak out in no uncertain terms because they felt his reputation was being injured. The following is a representative sample of what was being said, as quoted from the *Southwestern Stockman, Farmer and Feeder*:[73] " . . . The Luther Burbank Society has been conducting a campaign for funds and membership throughout the United States for a number of months in a manner which has placed Mr. BURBANK in a very equivocal position and has as a matter of fact made

[73] California Fruit Grower, Los Angeles, California, October 25, 1913.

his name largely a joke throughout the country. Mr. BURBANK has had his attention called to this matter, but the methods used by the Luther Burbank Society continue to grow more outrageous rather than to show any improvements. When it is stated that but one hundred or so 'noted personages' are wanted to form the society and when one finds that every person whom one has heard of in almost any part of the United States has been included in the invitation to become one of the 'noted personages' in the society within the limits of a hundred or two — without going into any further details, it certainly is clear that something is wrong, and it is a shame that anything of this kind should have become connected with the name of LUTHER BURBANK."

Although the membership scheme was in the nature of a hoax, those who signed up received their books as promised but they had no chance to edit the text in any form. Six years later I purchased a full set of the books — not ten but twelve volumes — from a Chicago department store for $17.00.

The last phase of the Company's activity consisted of plans for publishing several editions of an eight-volume set of books (essentially the same as the twelve-volume set but more condensed), which had to be financed by a huge bond issue. Full-page advertisements began to appear in the leading local newspaper,[74] and continued at intervals for the next three years. The first offered "the unsubscribed portion of $80,000 Luther Burbank Press, 7 per cent five-year compound notes. Free of taxes. . . . Interest payable . . . . every six months. . . . Subscription period closes Saturday, November 9, 1912. All applications sent on or before that date will receive a bonus of 25 per cent in stock. . . . . The total authorized issue of these notes is $300,000. More than $100,000 has already been subscribed. Only $80,000 of the balance is available for subscription in Sonoma County. . . . ." As a morale-builder it was explained that "The Company known as the 'Luther Burbank Press' was originally set up by a group of prominent people from all over the United States who subscribed a total of $600,000 worth of stock — fully paid up [claimed to be], $480,000 preferred and $120,000 common. . . ."

The advertisements were craftily worded so as to make a special appeal to local people. Their pride was touched by such statements as, "It is the biggest business undertaking of its kind not only in Santa Rosa but anywhere west of New York and will turn over several million dollars a year at a profit of nearly half the turnover. . . . The Company's securities have not been offered to the general public heretofore, and the present offer is confined to Sonoma County for special reasons, namely: the company will need the cooperation of Sonoma County residents in securing larger postal facilities from the Post Office Department, in petitioning the Interstate Commerce Commission for more equitable freight and

[74] Santa Rosa Press-Democrat, Nov. 3, 1912, Nov. 2, 1913, Mar. 7, 1914. Jan. 12, 1915.

express rates (since, when the delivery of the books commences, the company's freight and express bills will exceed $100,000 a year), in securing from the Department of Agriculture unpublished or private statistics or information, and from the Panama Pacific Exposition [soon to be held in San Francisco] better than ordinary concessions.

"Further, the company has been strongly advised by its bankers and counsel to make this offer on the ground that local influence is best secured by making it possible for local residents to have a share in the profits originating from a local enterprise of this magnitude and exclusiveness."

A year later pictures were shown of the busy offices and mailing room. Postal receipts were so heavy that the local post office had to be reclassed, upward, more than once. They were very proud of their "efficiency" system of advertising the Luther Burbank Society, as well as their methods of selling stock and taking orders for the books. This was a mail order business exclusively. Apparently it was the twelve-volume, $181.00 edition, that was being sold. The eight-volume set came later, and the five fantastic special editions were to come along still later. It was claimed their card index files contained more than a million addresses of prospective customers. The advertisements related how two of the high officials of the company had been brought from the east where they had been in charge of enterprises that ran into the millions — that they were go-getters and no mistake, and concluded with the slightly apologetic statement — for Santa Rosans — that, "Although it [the company] now maintains offices in San Francisco, Chicago, and New York, the Santa Rosa office is, and will continue to be, the principal place of business. . . ." All of which was very impressive and, in the language of the popular song, "My God how the money rolled in."

In a supplementary broadside issued the same year chiefly, but not exclusively, addressed to local investors, the writer of the advertising copy — presumably Mr. JOHNS, the moving spirit of the enterprise — really let himself go as he told about plans for the publication of additional sets of books and the phenomenal profits that might be expected to follow. Five editions were projected. In reality, four of them were to be identical in subject matter with the eight-volume set previously referred to but dressed out in different bindings and designed to serve special purposes. In the statement that follows it will be noticed that one set was to be made up of government and state agricultural bulletins, literature that had always been free to all for the asking, but the promoters were sure people would buy it readily if in some way it could be associated with BURBANK's name.

It was also glibly assumed that the public schools, colleges and universities would want the BURBANK books and other miscellany for teaching purposes, an assumption that was truly a masterpiece of absurdity. That these gems of optimism may not be lost, I quote them in full:

"1. Popular edition in 8 volumes to be sold to 7,000,000 farmers and 4,000,000 rural and suburban people — 50,000 sets at a net profit of $10 a set.

"2. The text book edition, consisting of a series of 8 books, 2 for primary, 2 for grammar, 2 for high school, and 2 for college grades — 17,000,000 copies annually, $1,200,000 at a profit of $200,000.

"3. Special reinforced library edition, 8 volumes, same as popular edition except bound especially strong for frequent handling — 15,000 copies. The Burbank books are a necessity to the libraries and their entire demand can be supplied within two years at a profit of $300,000.

"4. The special Monograph Edition, consisting of a series of approximately 3,000 bound bulletins and booklets to sell at 10 to 50 cents, each dealing with one specific subject, to solve the soil tiller's specific problems and to give him precise information on specific subjects, the information to be collected from reports of the United States Department of Agriculture and of the various states. An estimated business of $250,000 a year can be developed at a profit of about $50,000 a year.

"5. Foreign edition, of 8 volumes, same as American Popular Edition but translated into French, German, Italian, Spanish, Japanese, and Russian, and adapted for sale in England, Australia, South Africa, and Canada. Total market as great as for the United States."

At no time have I been able to find any editorial comment, either in approval or disapproval, in any of the newspapers of Santa Rosa or the environs where stock sales were heaviest. Apparently the community was stunned at the unheard-of developments in its midst and simply waited with baited breath for the golden showers to begin descending upon them.

A final announcement was made in January, 1915, to the effect that the 12-volume set of BURBANK's work was complete, after three years of work and the expenditure of $400,000. Also that the headquarters of the sales organization was being moved to New York City and that agencies would be established in a number of large cities. How many sets of books were published, and what Santa Rosans thought about the removal of the head office from their town, is not indicated in the public records of the day. Subscribers had now received their copies of the 12-volume set and apparently plans were far advanced for issuing the condensed 8-volume set, but I am under the impression that it was actually finished and put out by BURBANK and his own helpers as a part of his salvage after the corporation failed.

The early part of 1915 seems to have marked the high point in the affairs of the Luther Burbank Press and thereafter they went into rapid decline. Complete collapse came within a few months. Presumably the stockholders lost their entire investment. Very naturally they were bitter on account of their losses, but oddly enough, taking the country as a whole, BURBANK's personal reputa-

tion suffered less from the stock selling schemes than it did from having his name associated with the phony Luther Burbank Society. The first was a business affair only, the second was more than that; it involved sentiment. There probably were many more of the latter, too, despite the alleged 500 limit to the membership, and they were far more widely distributed. When they discovered they had been used to further a larger scheme their emotional reactions ranged from embarrassment to disgust; they felt they had been duped by one they had trusted, because to them, the "Society" was a personal attribute of BURBANK himself. They were proud of their membership: for was it not stated in black and white, in the literature they had received, that they had been singled out to become honorary partners of the great man and would be asked to advise him when he began writing his books?

That these "memberships" were highly valued is well illustrated by a personal experience at the Panama Pacific Exposition in San Francisco in 1915. The horticultural section of the Jury of Awards found itself in need of an authority on apple varieties of the eastern United States. I suggested GEORGE T. TIPPIN, a Missouri fruit grower, and he was appointed. When he reported for duty at the jury room — being a stranger — attendants questioned his right to enter. He was arguing the case when I arrived, just in time to hear his concluding statement, made with great dignity and intended to be crushing: " . . . . and I am a member of your own Luther Burbank Society." The situation was delicate. I contrived to advise him not to parade his "nearness" to BURBANK. He didn't like this but consented when told that none of the rest of us had been honored with "memberships." Later, with full information, he was crestfallen, saw his dreams of prestige fading away, was an unhappy man. He even lost his desire to visit the BURBANK place, which had been his dearest wish when he left home. It was no use to remind him that BURBANK had not planned or organized the "Society," had practically nothing to do with it, and should not be blamed for everything. But he would have none of it. He said he had been deceived by somebody and thought BURBANK was the man to hold responsible for the deception, which, I believe, was typical of many others. So far as I can learn BURBANK never made the least effort to clear himself of charges of this kind.

The Luther Burbank Company (the firm that was to sell his fruits, flowers, etc.) was the second concern that failed and cast aspersions on BURBANK's name. This was another scheme that grew up like a mushroom after a warm rain. Whereas the Press was operated on a national scale, the Company was international in its scope. The first was a manufacturing concern while the second was strictly a sales organization. Both sold stock extensively and in both cases the stockholders lost their money.

The chief promoter of the Luther Burbank Company was one ROLLO J. HOUGH, a minor official of an Oakland bank. HOUGH gave the impression of being a man who was "stepping out" after a period of enforced suppression of his talents in a sedate banking

institution. Self-confident and optimistic by nature, he threw himself into the new enterprise with a bounding enthusiasm that was matched only by his driving energy. Undeterred by the fact that he had no personal knowledge of the seed and nursery business, he evidently felt that talent of this kind could be hired when needed.

Public psychology was at the right pitch for commercializing BURBANK's productions, that is, for interesting capital in such a selling scheme. His fame was so great that many believed, and others were easily convinced, that his products would sell themselves — that it was only a matter of setting up the necessary operating machinery to place them in the hands of the customer and gather in the money; that the customer would be satisfied with what he got and would want more and more was taken for granted. It was only a question of merchandizing, like selling bricks or nails which everybody wanted in unlimited quantities, with only one man possessing the secret of their manufacture.

This was the situation in 1912 when BURBANK was at the peak of his renown — when his name was a byword in a dozen languages — and explains the state of the public mind that made possible the organizing of the huge selling concern involving the investment of hundreds of thousands of dollars.

It might be expected that men of experience in managing banks and corporations would not be swayed by sentiment or mass hysteria but here they were with their money in their hands ready to back their favorite. If the names on the first board of directors [75] of the new company was a fair sample of the other purchasers of stock, the investment must indeed have appeared attractive alike to bankers, merchants, capitalists, investment brokers, doctors, and lawyers. With two great universities near by one may wonder why there was no representative of that supposedly most gullible of all groups — the college professor — for there were a few BURBANK enthusiasts both at Stanford and California. One answer is that as a class they were unresponsive to the BURBANK appeal, and another is that they probably didn't have the money.

I want to make it clear that while there may have been stock juggling as charged [76] when the Company was breaking up three years later, the great majority of the stock purchasers put up their money and held on to their stock because of an abiding faith in BURBANK's products, which, in a final analysis, meant a child-like faith in the man himself. And, I repeat, that BURBANK at this time certainly believed in his own productions. Many of his fruits and some of his flowers had made good in a big way and his state of mind would not allow him to doubt the value of the others that had not yet been tried by time, and the stockholders accepted everything at his own estimate.

In his dealings with the Company BURBANK had the benefit of excellent legal advice. When in need of the services of an attorney-at-law it was his policy to employ the best talent available and the

[75] Santa Rosa Press-Democrat, Santa Rosa, California, December 3, 1912.

[76] Santa Rosa Press-Democrat, Santa Rosa, California.

vicissitudes of his business had occasionally made it necessary to have such help: to stand by him when he repudiated the agreement with the LAW Brothers, to write contracts with the big seed companies he transacted business with, to prosecute an express company for the loss of a ten thousand dollar shipment of cactus to Australia — to mention a few representative cases. While he made use of local talent on occasion, his more serious business affairs were entrusted to Attorney F. S. WYTHE of San Francisco. The demands on his time by the minutiae of business irked him sorely and he evaded as much of it as possible to the despair of his office help. But when it came to entering upon a basic contract that involved a big sale he ran true to his native heritage, for at heart he was a shrewd trader and could drive a hard bargain.

Because BURBANK was a romantic character and because his eccentricities and seemingly careless business habits had received considerable publicity, he gained the reputation of being an "innocent" and a potential "easy mark." People of meticulous business habits could reach no other conclusion. All of which must have caused him many an amused chuckle for, to a certain extent, I believe he really enjoyed the glamor of this devil-may-care reputation that had been pinned upon him. In a way it was an asset when he came to sell something — to appear innocent. At this time he was in a position to control the price of his wares because he had no real competitors. He was selling his own things and the public believed that no one else had anything as good.

Experienced seedsmen and nurserymen, who knew the comparative values of flowers and fruits, naturally were in a position to indulge in a certain amount of haggling over prices, although even they always were fearful that something might turn out to be of unusual value and that it might fall into the hands of a competitor, and so were impelled to snap it up without too much argument.

But now comes along a bunch of capitalists with ample means who wish to purchase all his present, past and future productions and will pay in cash or with seemingly good promissory notes and will take everything at his own valuation. Such a thing has not happened before — the proposition seems too good to be true. Yet, there it is; the offer is bonafide; there is no question about that; his attorney can find nothing the matter with it — his terms have been accepted, payment appears certain, all his troubles are over, he is at last a free man with security and time for pursuing his experiments; all vexations and worries removed from his life, so he signs the agreement.

But BURBANK has a big bump of caution — there may be a nigger in the woodpile somewhere — so he tries to make assurance doubly sure by providing that he is to name the president of the Company and have his attorney made a director and through him approve the other members of the directorate.

The Luther Burbank Company was incorporated in California by ROLLO J. HOUGH and W. GARNER SMITH on April 22, 1912, but

the organization was not completed until the following November. In the meantime, a corporation called the Universal Distributing Company was set up to receive such things as BURBANK was ready to release and to establish nurseries and seed farms for multiplying them, for it must be remembered that BURBANK never had more than small stocks of new things on hand and it would require from one to three years to increase them in quantities sufficient for selling at wholesale. And this is where some of the troubles began that were later to rise up and plague the management. Even though they may have been inexperienced in conducting a nursery and seed business they did recognize this. In their first general catalog,[77] bearing the date of 1914, they say, "naturally, years must elapse before sufficient quantities of seeds of certain varieties can be obtained for general distribution. . . . When BURBANK completes a new creation he delivers it in the form of a few ounces of seed or a few feet of grafting wood, as the case may be, to the propagational department of the Luther Burbank Company. Sufficient quantities are then produced for introduction to the world at large."

In their initial announcement seeds were their first offering; no fruits except two blackberries and a strawberry. There were also two or three dozen kinds of bulbous plants and a couple of roses — all things that had been offered by BURBANK in previous years. Then followed about 30 pages of standard seeds consisting of flowers and vegetables and a list of more or less well-known roses that were popular at the time.

The Company thus went into the general seed business at once but at the same time handled over a hundred different kinds of seeds and bulbs advertised as BURBANK productions, although all but a very few of them had been offered before by BURBANK himself and presumably he had small stocks of each on hand to turn over to the Company. Apparently the Company did not offer anything for sale the first year, 1913, except cactus — at least I have not been able to find any advertising literature covering that period, aside from the pamphlet on cactus. Presumably all the BURBANK things were being propagated as rapidly as possible. Even so it seems incredible that a sufficient stock could have been accumulated in so short a time to properly fill the flood of orders that must have been received as a result of the intensive advertising campaign that was being carried on and which had been going on for the past 12 or 14 months.

There was much complaint from customers who felt that the goods they purchased were not as represented. Some carried their complaints and suspicions to the newspapers, but the greater number suffered in silence or made sarcastic remarks to their intimates. This latter group was widely distributed and because, in the aggregate, the number of individuals was great, a legion of people heard that LUTHER BURBANK was guilty of sharp practices and in too

[77] BURBANK Seed Book, pp. 7 and 8, 1914.

many instances that view was passed down to the present generation. Not one per cent of the hundreds and hundreds of people I have contacted knew that the Company was separate from BURBANK. Those that had some inkling of the existence of a company thought that it was organized by BURBANK and that its policies and practices were dictated by him.

Owing to the disclaimers[78] included in their catalogs, (the usual practice of vendors of seeds and plants) it was exceedingly difficult to secure redress from the Company. If willful misrepresentation could be established, such as selling a seed or plant of common origin as a BURBANK production, then a judgment in court might be secured awarding something beyond compensatory damages.

When ROLLO HOUGH was promoting the Company he approached GARNER SMITH, a young insurance man and stock broker of San Francisco, who became so enthused with the plans that he invested a small fortune in the venture. Being a salesman by profession SMITH became a valuable man in the organization and was selected as its secretary-treasurer. JAMES F. EDWARDS of Santa Rosa was president. It was young SMITH who had the foresight to establish seed farms and nurseries to multiply BURBANK's novelties which were taken over in small quantities. He later acted as a salesman for such things as the Company had ready for placing upon the market.

At the time SMITH associated himself with the Company, he had great faith in the things put out by BURBANK, so much so that as a matter of pride he made up a collection containing every novelty that BURBANK could deliver and sent it to his father to be planted on the latter's farm in Kentucky. The collection occupied an area of six acres. SMITH Senior planted everything with care — fruits, flowers, grains, cactus, and so on, but scarcely anything proved to be of any value. This was disappointing — even humiliating — to young SMITH, and his faith in BURBANK as a producer of wonders in plant life dropped to a low level.

During the year 1913 the income from sales was small, possibly because there was little to sell outside of standard articles that could be secured from any seed house. At this time there was dissension within the management regarding matters of policy. Some thought a vigorous sales campaign should be instituted, while others opposed the plan. It was becoming apparent that something was radically wrong. First of all it was evident that such things as had been sold as BURBANK novelties had not made good, and there was much complaint and few repeat orders were received.

Early in January, 1914, in the face of this situation, GARNER SMITH took the road as a salesman for the Company. He visited

[78] "We guarantee the seeds, plants or trees sold by this Company true to name and will replace any that may prove otherwise through a possible error, or will refund original purchase price. Our liability upon any article sold is limited to the original purchase price, and all sales are made with this understanding." BURBANK Seed Book, page 77, 1914.

the principal cities in the eastern and middle states. In three months, although the usual buying season was long past, he was able to book orders amounting to thousands of dollars, especially from establishments like department stores. As evidence of the growing lack of harmony in the Company, most of the orders were turned down by the Manager who had decided to raise prices.

SMITH returned from his trip with definite ideas regarding policies to be pursued if the Company was to make a place for itself in the highly specialized seed business. It being clear that steady customers could not be expected for BURBANK's novelties, the next best thing seemed to be to go fully into the business of growing and selling of standard seeds after they had been thoroughly tested and found to be dependable. He believed that a combination of the very best seeds that could be grown, together with the prestige of the BURBANK name, would be an unqualified success. This plan was not approved.

One of the biggest mistakes of HOUGH, the Manager, was his refusal to see the necessity of employing skilled help to oversee the growing of seeds to keep them true to name and type. For example, GARNER SMITH [79] recalls an instance on one of the Company seed farms where two varieties of seed corn were being grown side by side where they would be certain to contaminate each other. To be sure, knowledge of scientific plant breeding was scant in 1913 but enough was known, and in the hands of practical people, to have made it possible to grow pure seeds. Indeed, most farmers and gardeners knew that to be kept pure a variety of seed corn or seed melon must be kept isolated from its kind to prevent mixing through cross-pollination. But the Manager and his field helpers did not appear to know that this was important or did not care.

Irreconcilable differences on questions of management became so acute that SMITH resigned on April 25, 1914. President EDWARDS, too, had resigned a short time earlier. Both men made the mistake of not demanding that their stock be taken off their hands, and both lost their entire investment which, combined, amounted to well over one hundred thousand dollars.

At first in 1913 or early 1914, dividends as high as twelve per cent were paid to stockholders as a result of heavy sales of cactus, but in the spring of 1914 financial difficulties began to be felt and dividends quickly dropped to six per cent and later ceased entirely, and nothing was paid thereafter.

During the latter half of the year 1914, money troubles became so real that the semi-annual payments to BURBANK could not be met promptly and notes had to be given him in lieu of cash. The pinch was due to a variety of causes, one of them being overexpansion with consequent high overhead, especially rentals and salaries, but from the Company viewpoint the difficulty was caused by the failure of the BURBANK novelties to make good; to the high prices exacted by BURBANK for his novelties; and finally to the

[79] Conversations with Mr. SMITH, November 8, 1941.

heavy hand he held over the Company by exercising his prerogative of approval or disapproval of its officials and policies. Whether the Company was coerced into trying to sell unsaleable things now is not clear. BURBANK had a contract to deliver everything that was ready for release and doubtless he saw no reason why they should not receive them, start them through the expensive process of multiplication, and finally place them upon the market. And of course he wanted his money.

In 1914 the Company continued to expand and BURBANK was becoming more and more insistent that he be paid what was due him. The newspapers of the time stated that BURBANK was about to bring suit against the Company, although many were pleading with him not to do so. The Santa Rosa Press-Democrat of December 31, 1915, said:

"After having waited and waited for the Luther Burbank Company, the Company which took over his seed and other productions, to pay him what he had been owed for a long time, LUTHER BURBANK has commenced a suit against the company in the superior court of San Francisco to recover the sum of $9,775 due on promissory notes.

"Further than this, Mr. BURBANK has notified the Company of his cancellation of the contract which bound him to turn over his creations to the company. In other words, the expected has happened, and what was once one of the most golden opportunities upon which any concern had to build up a tremendous business, has been allowed to dwindle owing to gross mismanagement of its affairs.

"From San Francisco Thursday came word that Manager PITTS and the directors will put forth every endeavor to get Mr. BURBANK to reconsider the course which he has decided upon and for which he cannot be blamed in the least, for his experimental ground expenses do not cease as his great work proceeds. There is to be a meeting between the directors and Mr. BURBANK next Monday.

"In the event of Mr. BURBANK deciding to adopt the course he has outlined and refuses to allow his name or his products to be handled by the Company, then there will be nothing to do but to liquidate the concern. It is well known that Mr. BURBANK has been willing to do most anything to keep the company in operation if the contract was lived up to. Among the stockholders in Santa Rosa, and there are a number, and elsewhere, there are some of his most intimate friends.

"'BURBANK has been the victim of stock pirates,' said Attorney WISE. 'This Company was formed three years ago. He took no stock in it and no interest in it. Some of the best men in town have also been made victims. . . . Stock to the amount of $375,000 has been sold to the public at par. The Company agreed to pay BURBANK $300,000 in terms of $30,000 cash and $15,000 a year. They were to have exclusive rights to sell all his products.

"'They paid him the $30,000, sold stock like hotcakes and never paid him another dollar. BURBANK has delayed action for a

year because of sympathy with the excellent people involved. He has now cancelled the contract, forbidden use of his name, and has brought suit for $10,000. Another suit will be brought for $15,000. These suits are arrearages.' "

There were criminations and recriminations, including a libel suit against Attorney WISE, BURBANK's lawyer. Pleas were made to BURBANK to stay his hand; to give the Company more time; that disaster on a big scale would result if he persisted in going through with the suit and forbidding the Company to use his name. But BURBANK was thoroughly angry; his resentment had been growing for months. When I visited him three months earlier,[80] with flashing eyes he declared that the Company had swindled him out of everything he had, which, of course, was an exaggeration but he was crippled financially with his normal income from sales having been cut off for two or three years and his regular maintenance expenses going on all the time.

At any rate he stuck by his guns and on February 8, 1916, the Company was declared to be insolvent. The assets were small and stockholders received little or nothing. BURBANK held preferred claims but even he lost heavily, although he did regain possession of a considerable stock of seeds and plants that remained unsold.

After his experience with the two bankrupt firms, BURBANK was a changed man — something had gone out of him. To seem in the eyes of men to be a failure was galling, even humiliating. Many of his personal friends suffered financially from the two catastrophes, but it was known that he had probably suffered greater money losses than any of them and local people, understanding his embarrassment and feeling that he had been imposed upon, did not hold any personal resentment against him.

BURBANK rehabilitated his business as rapidly as possible but by the time all legal adjustments were made the season of 1916 was too far advanced to sell anything. He intimates, also, that there was little stock on hand of the things he valued, for it has already been recounted that the Company was in the general seed business rather than dealing in BURBANK specialties, as the world believed.

This chapter of BURBANK's life closes with an official statement, under date of July 1, 1916, in the form of a leaflet, which he no doubt distributed widely, to the effect that the Company was out and that he was again in sole charge of his seed and nursery business.

---

[80] Santa Rosa Press-Democrat, September 4, 1915. "A party of horticulturists, members of the American Pomological Society, now meeting in Berkeley, visited LUTHER BURBANK today. The group consisted of Prof. W. T. MACOUN, Dominion Horticulturist of Ottawa, Canada; Dr. W. L. HOWARD, Associate Professor of Pomology, University of California at Davis; ELTWEED POMEROY Jr. of Donna, Texas, Vice-President of the Texas Horticultural Society; Prof. L. R. TAFT, East Lansing, Michigan, and VESTA C. HANEY of East Lansing, Michigan. Governor BRUMBAUGH of Pennsylvania also visited BURBANK the same day." My party had to leave early, but at Mr. BURBANK's special request, I remained three hours longer.

IX

BURBANK THE PARIAH — OF SCIENTISTS

TO THE Brahmans of science BURBANK was an Untouchable. They almost dreaded his shadow. His literature was taboo; hence few preserved his seed and nursery catalogs. If one valued his reputation among his colleagues, he must not be caught with a BURBANK catalog on his desk or a BURBANK book upon his shelves. Extremists regarded him as a parody — an imitation scientist — and his bid for recognition as ridiculous. To be sure there were liberals here and there, but they seldom raised a voice in protest.

BURBANK's practical attainments were of no avail. They were either disbelieved or ignored. Many, both in and out of scientific circles, did not know what to believe. There were conflicting stories and prejudice was rife. Had not men of orthodox training tried to improve economic plants by breeding — by following the most approved methods of technique and record-keeping — and got precisely nowhere? Then how could one who violated all the rules expect to be successful? For a Brahman to admit such a possibility would be a reflection on his caste.

The chief period of controversy comprised the years 1893 to 1912. Those were also BURBANK's most productive years; and had he passed out of the picture at the end of that time and a balance been struck, the historian's task of summing up his career would have been simplified. After that there was less to his credit and more to apologize for. While it is true that the adverse opinion of the scientific world was pretty well hardened by 1912, events of the next few years tended to confirm that view, and unfortunately — as well as unjustly — a considerable portion of the lay public either was converted to that belief or left hopelessly bemused.

A potent reason why he was beyond the pale of institutional scientists was the fact that he engaged in the nursery business. That this situation was forced upon him was beside the point. Pursuing the methods of the nurseryman and observing the ethics of the plant salesman of his time, he marketed things of doubtful value. All of this was violently contrary to the ideals of the scientific profession and made him an object of mistrust. Rival nurserymen helped to plant seeds of suspicion against him. Did he really produce by breeding the new plum trees he was selling, or did he bring them all direct from Japan? Was the Shasta daisy truly a product of breeding or an importation from somewhere? Did he breed a race of cactus devoid of spines or did he only bring in the different thornless types intact, from Mexico or Africa? And finally, was there any merit to his claim that he had successfully

produced a new species, as claimed, by hybridizing the western dewberry (*Rubus ursinus*) with the Siberian raspberry (*Rubus crataegifolius*)?

If science stands for anything it is truth and accuracy in deed and statement. Students have been taught that a legitimate scientist does not ask the world to accept his unsupported word for statements he may make in announcing the discovery of a new truth or an improvement on an old one: he submits the evidence on which his conclusions are based. This is the picture of a conventional scientist, such as is fostered by educational and research institutions of all civilized states.

But science is a tool that is used for many purposes — for war, peace, industry; for the cure of the sick and alleviation of pain; to prevent accidents and unnecessary hazards; to improve government; for the detection of crime; for the promotion of human happiness. Its uses and objectives are legion. We come into the world under its ministering hand, and go out again in spite of all our accumulated knowledge, because in many directions science still stands baffled by the laws of Nature.

One universal use of science is for the promotion of commerce and industry — for personal gain, if you will — and these in all their ramifications make government itself possible, for, of course, this benevolent parasite on the body politic must be supported. Manufacturing and processing may be, and usually are, highly technical, and these various technologies are based on one or more of the sciences.

A knowledge of science or the technological use of it is not necessarily acquired in the laboratory of an educational institution although that is the usual way. There is such a thing as the scientific temperament. Some are born with it, some are not. I do not mean to assert that scientists are born, not made. But I do mean that an individual with a small talent of this character may, by cultivating it assiduously, in lecture room and laboratory, become a fairly proficient technician; while another with a pronounced talent but with only meagre cultural opportunities may, by following his bent his own way, succeed in accomplishing something worth while, without formal training.

Almost without exception the authoritative scientists of the world have had talent as well as opportunities for cultivating it. The institutions of the country are manned from this group. Here and there in history we learn of individuals who, though handicapped by lack of formal training, have nevertheless risen above their environment and become famous for their accomplishments. But their task was made doubly hard because those with formal training are extremely skeptical of the accomplishments of individuals who are not formally trained and at best are liable to accord them only grudging recognition.

George Stephenson the elder was ridiculed by the educated engineers of his day when he was building a locomotive designed to draw a train of cars. Why? Because it was known that he

never learned to read and write until he was past seventeen and that what little elementary education he had was obtained by attending a night school. ROBERT FULTON had much the same experience when he was about to navigate the Hudson by steam power. MENDEL, the monk, was ignored by the botanists of his day when he published his epoch-making paper on the laws of inheritance of characters in the garden pea. Educated, yes, but nothing serious in the realm of science could be expected from the clergy! CYRUS W. FIELD, builder of the Atlantic cable, was thought to be a featherbrain. EDISON and MARCONI had to fight for recognition because as scientists they were not to the manner born. CHARLES DARWIN, educated for the Church, was something of an exception. He no doubt would have been ignored by scientists on account of the character of his education but he simply overwhelmed them with the mass of evidence that he submitted in proof of his convictions regarding the origin of species and related matters. But perhaps the most humiliating experience of all was reserved for the WRIGHT Brothers when it became known that they seriously thought they could build a machine that would enable men to fly. What could be expected of two young men who had barely completed high school? And SAM LANGLEY, an educated man, who had faith in their ideas, was ridiculed to his death.

BURBANK had the research temperament. In fact he was a "natural." But to the conventional scientists of his time — especially botanists; later, plant breeders; and still later, geneticists — he was an Untouchable. Others took their cue from workers in the biological sciences, for presumably they knew BURBANK best; and because caste is strong, the word has been passed down the line to this day. While BURBANK was alive they rarely went near him, never tried to ascertain the facts, and many of them would have been embarrassed to be caught reading anything he had written or any of the books that were written about him. I have contacted scores of scientists, young and old, and find, almost without exception, that they speak kindly of him as a man, but those under forty or fifty are apt to say they have "understood" that, scientifically speaking, he was not to be taken seriously.

From the older biological scientists, especially those in Colleges of Agriculture where men must be realists and in Federal departments having to do with plant culture and improvement, we hear a very different story. With only a small dissenting minority these groups show a willingness to commend BURBANK's virtues and forget his faults. They point out that he accomplished much direct good in the world by his contributions and even more, indirectly, by the stimulus he gave to plant breeding.

Without trial and without seriously trying to determine all of the facts, BURBANK was condemned by institutional scientists on at least six counts: he was untrained in science; he was a nurseryman — sold trees, seeds, etc.; he permitted people to make exaggerated claims for his prowess — even linking him with the supernatural; he was lacking in humility — fought back when

criticized; he knocked at their door — or allowed his admirers to do so — when he should have waited for an invitation to enter; and finally he did not have the attitude of a scientist — did not conform — and his methods, it was charged, were so unreliable as to vitiate or invalidate his conclusions.

X

BURBANK THE DISAPPOINTED

OF COURSE, the major disappointment of BURBANK's life was that he was not accepted whole-heartedly by the scientific world. However, an element of pathos permeates the situation, for deep down in his consciousness I cannot believe that he personally cared much whether he was accepted or not. To have been accepted would have been merely a saving of face, a balm to his pride, because throughout most of his life certain things were expected of him by his family and his admirers, and he simply had to live up to expectations. Time and again well-meaning friends, who mostly did not know the meaning of the word science, had told him that he was a scientist and proclaimed him to the world as such. His enthusiastic biographers carried this idea to lengths that bordered on the ridiculous, especially HENRY SMITH WILLIAMS, who tried to prove that BURBANK independently discovered and demonstrated the basic principles of heredity — afterwards known as MENDEL's law — at least a year before the announcements of DE VRIES, CORRENS, and TSCHERMAK, but the job was so cleverly done that BURBANK seems to have tried to believe that all he said was true.

If his friends had been more moderate in their demands for recognition of their champion he might have been happier. Laurels enough had come his way to satisfy most men. He loved adulation but his friends and those around him seemed to want the unattainable. They wanted him proclaimed a second DARWIN and have his name in the textbooks. ROBERT JOHN and OSCAR E. BINNER actually announced plans for having BURBANK write a series of books to be used by college students, but before they got around to it their bubble burst. And perhaps it is just as well they didn't. What the proposed books were to teach was not made clear but presumably they were to be made up from material in the 12-volume set[81] that was published by the Luther Burbank Press; however, I fear they never would have been adopted as texts by any college or university and their rejection would have been humiliating to the author.

It should be understood that the publishing of textbooks was not BURBANK's plan but a scheme of promoters for making money. Possibly the announced plan was only propaganda for selling more stock in the publishing enterprise and BURBANK was their dupe.

A keen disappointment in BURBANK's life was the way the clergy turned against him when he needed their support and felt that he had a right to expect it. He hadn't asked them to seat him

[81] LUTHER BURBANK, His Methods and Discoveries and their Practical Application.

upon a pedestal. But he accepted the distinction, and, despite official denials to the contrary, he was terribly hurt when they toppled him over. Also, heaping indignity upon injury, they refused to understand him when he sought to explain his position. This intolerant attitude gave him a taste of medieval cruelty that cut him to the quick. He was no heretic that needed to be forced to recant; he had never professed to believe some of the things the clergy considered basic to Christianity; they had merely assumed that he did.

Of course, I do not know whether he ever admitted to himself that he had allowed his admirers to give him a false build-up and that he had passively accepted it along with other forms of adulation that were hard to live up to. But it is not likely that he would convict himself of anything smacking of hypocrisy or insincerity. He had set himself up as a moralist and guide for children and youth to follow, and perhaps it was not illogical that the clergy should take the rest of his beliefs for granted. It may have been a misunderstanding or it may have been wishful thinking; it all adds up to the same thing. Even though a few clergymen came to BURBANK's rescue and did their best to defend him and give him a chance to defend himself, the gesture was futile. He was engulfed by the storm and had to accept the situation. He took refuge behind his philosophy of kindness and good will towards all, then shrugged it off and tried to forget. But he emerged with a certain understandable bitterness and mistrust toward the Church which never left him. However, all this, I believe, had nothing to do with the atheistic setting of his funeral when he died a year or two later, at least insofar as his own wishes were concerned. He had arranged long before for a distinguished atheist (Judge LINDSEY) to deliver his funeral oration but the Ingersollian burial service was another story, as related elsewhere in these pages.

Minor disappointments in his life were the years of anguish following his unfortunate first marriage and his differences with the Carnegie Institution which granted him a generous subsidy and then withdrew it. Not that he was not relieved to be free from the tyranny which their discipline imposed upon him (from his viewpoint) but the withdrawal of the subsidy caused him to lose face, and in this regard he was as sensitive as a Chinaman. The same principle was involved when his friends tried to prevail upon Congress to set apart a large tract of desert land in the Southwest for a demonstration of the value of spineless cactus as a stock feed, and the plan was turned down. The measure was approved by the House but was allowed to die in the Senate. I don't think BURBANK wanted the land. An ironic feature of the case was that the measure was not defeated on its merits but because cactus selling, for planting purposes, had become a racket, and dealers were using the pending legislation to mislead their deluded customers. In itself, the idea was a meritorious one. If carried out it would have brought a show-down on the value of this crop which, by the way, might have introduced another disappointment into BURBANK's life.

XI

BURBANK THE WORLD CHARACTER

FOR thirty years BURBANK was definitely a world character. He was visited by royalty and notables from most of the principal countries of the world. His place at Santa Rosa was a mecca for tourists. As he became a legend, his gardens became a shrine.

BURBANK was a master showman. He had the good sense to appear natural, even when he must have been inwardly perturbed in the presence of numbers. The good opinion of himself that he held, combined with a certain shyness, enabled him on all occasions to maintain a serenity and poise that was charming in its seeming simplicity. His self-assurance would not permit him to kowtow to the rich or the mighty ones of the earth, nor to indulge in socio-political tricks to win the plaudits of the proletariat. All comers were required to meet him on his own terms and, such was his assurance, they could accept him or leave him — it mattered not a whit to him. It was all in the day's work.

Various motives brought the people to his door. The majority came out of curiosity, not exactly as they would go to the zoo, but to see a notable they had heard much about like taking a peek at the President of the United States or some reigning monarch, or visiting them if they dared. To shake hands with him was a benediction, something to treasure as a unique experience — like the old crone in the story who was wont to say, "Children, these old eyes of mine once beheld Queen Victoria." And I feel bound to add that these statements are not intended to be ironic, and they are not overdrawn.

It is not surprising that certain of the visitors harbored strange ideas about the man, that they somehow expected to see a freak — some one with an extraordinarily large head, or wearing a halo instead of a hat. It was not uncommon for a sightseer in a crowd to remark to a companion in all seriousness, as though thinking aloud, "Why, he's only an ordinary-looking man and not a very big one at that. It's hard to believe he has done all the wonderful things I have heard about."[82]

Many, perhaps most, of the curious were admirers of BURBANK and, of course, when they visited him it was in a spirit of reverence. Along with the merely curious they were content to remain outside the low picket fence and patiently wait for a glimpse of their hero as he went about his work. These loiterers were often a source of irritation and annoyance to BURBANK, as they were apt to enter into conversation with employees with the

[82] Conversations with persons that were employed by BURBANK.

BURBANK'S TWENTIETH CENTURY GLADIOLUS

OFFERED FOR THE FIRST TIME
WITH OTHER NEW AND RARE

BULBS

MOSTLY UNOBTAINABLE ELSEWHERE

1911-1912

TO JUDGE NOVELTIES: LOOK TO THEIR SOURCE

The New Gladiolus: A Revelation

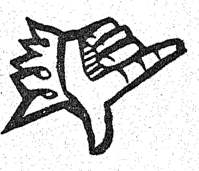
THIRTY years ago the Gandavensis type of Gladiolus was the leader, but the flowers were so fugacious that they were of no value in dry, sunny climates, the flowers wilting each day almost as soon as opened like the flaccida type of Cannas. By several years' growth of seedlings and most rigid selection a new strain with short, compact stalks bearing flowers of great substance was produced on our farms. This strain was introduced in 1889. Later, as other matters required attention, the entire stock of these was sold to Mr. A. Blanc of Philadelphia, and Mr. H. H. Groff of Simcoe, Ontario, Canada; we had before sold many of these to other well-known growers of that time. (See Bailey's Cyclopedia of American Horticulture, page 647.)

"Gladiolus America" has been esteemed both by American and European growers as being by far the most vigorous and easily grown Gladioli known. When "America" first came into our hands, several years after our first experiments along this line had been discontinued, its vigor and other general good qualities induced us to make one more effort to improve the Gladiolus. All the beautiful Gladioli here offered, and others even more beautiful still to be offered, originated on our farms from America as the seed parent, but all new or unusually choice or unique varieties obtainable anywhere at any cost were used for pollen parents. The results, after a few years, were astounding and we now have without doubt the largest, most brilliant and most varied ones growing on this earth, and of a new and distinct type. We happen to know this, not only from experience and actual comparison point by point, but these facts are corroborated by those who are growing Gladiolus themselves and who have carefully examined the stocks of those grown by practically all the great American and European growers. These new ones are a revelation in this the most varied, most popular and most easily grown of all bulbous plants.

The Gladiolus in California thrives perhaps as nowhere else, growing with a vigor and freedom from fungous diseases which elsewhere is wholly unknown, and the growing season is so long that the bulbs never need to be disturbed until fully ripened.

The varieties offered this season are especially rich in scarlet, salmon and crimson shades, which are now most rare and most sought for in all collections. The flowers of most of these are enormous and remarkable as well for their substance as for unusual size and brilliance of colors.

"The more impossible, the more certain it can become."



This new Burbank strain of Gladiolus will take its place in the hearts of the people like the Shasta Daisy: the most world-wide popular flower creation of the century . . . .

"He laughs best whose laugh lasts."

TEXTFIGURE 4.—COVER OF A 1911/12 LEAFLET.—BURBANK introduced more than fifty gladiolus varieties over a period of forty years. Several of these remained in the trade for ten to twenty years. He gave particular attention to varieties calculated to withstand the hot, dry winds of California. Several with specially stiff petals, quite different from ordinary types, were originated. The hyacinth-like arrangement of the flowers around the spike was also his contribution. Becoming discouraged on account of the ravages of gophers, he sold his entire stock to a Canadian fancier.

object of enticing them up to the fence to wheedle them out of a flower or fruit, or to make a chance for purloining something that would serve as a souvenir. Some were venal and tried, directly or indirectly, to snitch seeds or cuttings of things which they hoped might be valuable.

Among BURBANK's visitors was always a small percentage of scoffers. These were certain to stalk employees for the purpose of asking them questions often innocent, but sometimes of such a nature that they did not have the courage to put them to BURBANK, himself, even if they had had a chance to meet him. This matter of talking about BURBANK or his work was a source of supreme annoyance to BURBANK as he allowed no one to speak for him on any subject. If he caught a workman talking through the fence to a visitor, no matter how innocent the subject, he would fly into a fit of anger and occasionally the worker would be discharged.

After suffering much annoyance and some pecuniary loss BURBANK made a strict rule that employees in the gardens were to talk to no one either inside or outside the fence. He went a step further and instituted a system of searching the workers' pockets as they left the grounds. As one former employee remarked, "he treated us as 'high-graders.' "[83] For these and other reasons BURBANK changed workmen frequently and gained the reputation of being a difficult man to work for.

One class of visitors went to see BURBANK for educational reasons. This group included botanists, horticulturists, plant-breeders (both amateur and scientific), nurserymen, professional men and women, and others who hoped to gain information, extend their knowledge or enjoy the handiwork of one they regarded as an expert in his field. The professors viewed and appraised with scientific thoroughness — sometimes tinged with cynicism; the nurserymen looked with envious eyes at the long list of specialties such as they had dreamed of but never expected to see in real life; while others who had come to satisfy a yearning for a composite of beauty, the wonderful and awe-inspiring gazed on the whole picture of BURBANK's accomplishments as they would the Acropolis at Athens or a sunset from the heights of Taormina, and with much the same emotions.

BURBANK was a satisfying showman in the sense that no one regretted the time spent with him. He rarely made the mistake of keeping his visitors too long or showing them too much; they always went away hungry for more.

Visitors were an excellent source of favorable publicity — especially those that were received in person by BURBANK. All visitors that presented themselves were not received. No, not by any means, for this would have required all of his time. Those that were so fortunate were usually grateful for the privilege and became his loyal supporters. They told their friends and then the

[83] A term used at the gold mines to indicate persons who steal bits of high-grade ore. Even with the most stringent regulations mine owners experience considerable losses from this practice.

friends came; these in turn told their friends and so on, the volume growing by accretion like the proverbial snowball.

News writers were an even more potent source of publicity than visitors. H. W. SLATER, a newspaper man of Santa Rosa, claims to have given BURBANK his first effective push toward fame by way of the publicity route, about 1895, when he had contracted with a customer to produce a hardy tea rose for which he was to receive $5,000. This was spectacular enough to attract wide attention, not only for the feat itself, but for the princely reward as well. Stories of this kind have a way of traveling across oceans.

BURBANK's first bid to fame in the scientific world came with the publication of his catalog *New Creations,* in 1893. While this announced some of the best and most lasting things he ever produced — Japanese plums, Shasta Daisy — it is worthy of note that his fame, with the masses, did not stem from these attainments so much as from some of his more spectacular feats of much less importance, such as production of the plumcot, wonderberry, and spineless cactus. The press dramatized these achievements and the appeal was irresistible.

Chief among men of science, who were most effective in vouching for the authenticity of BURBANK's work — introducing him to society as it were — should be mentioned DAVID STARR JORDAN, President of Stanford University, and Professor HUGO DE VRIES, the Dutch botanist. JORDAN, with more or less help from his colleague, Professor VERNON KELLOGG, gave BURBANK considerable fame in his own country, but it was DE VRIES, unaided, who established his international reputation as a marvelous manipulator of plants and one who had performed wonders in hybridization. Of my own personal knowledge covering the twenty-five year period — 1905 to 1930 — I know that BURBANK's name was well-known in scientific circles in the principal European countries. Dealers in seeds and plants were even more familiar with his hybridizations — many of them being customers for at least a few of his productions in fruits and flowers.

In far-off places like South Africa, New Zealand, and Australia along about 1912 BURBANK was as well, or better, known than in the United States. Because his plums are a staple crop in South Africa, BURBANK still is highly thought of there, but in Australia his reputation suffered on account of the thornless cactus fiasco.

European botanists and geneticists were frankly skeptical of BURBANK's reputed attainments, regardless of the accolades of JORDAN and DE VRIES, for the reason that he had not published his findings in the usual way, in scientific journals. But there were the uncompromising statements of DE VRIES, a colleague in good standing, one of their own caste, and what could they do about it other than to accept what he said? Biographies of BURBANK by CLAMPETT, HARWOOD, and HENRY SMITH WILLIAMS, fortunately, they had not seen.

It must be acknowledged that part of BURBANK's reputation among the masses was due to notoriety rather than to fame. The

sayings of cheap writers and punsters may make a name a household word, possibly with unflattering implications, but at the same time there's no denying it helps to make the person a notable. Vaudeville jokesters do not make use of a name unless it is well-known, thus making it better known. BURBANK didn't like his name used in jocular vein because he hated ridicule; EDISON ignored such references, and HENRY FORD turned the jokes on his tormentors by capitalizing this kind of publicity.

First and last the church gave BURBANK a large amount of publicity by holding him up as a moral example for the youth of the land to follow; and later the Fundamentalist element condemned him to perdition because he insisted upon expressing opinions which they interpreted as being at variance with their own ecclesiastical beliefs.

Another source of undying fame to the name of LUTHER BURBANK is to be found in the public schools where a whole tribe of earnest teachers, mostly women, are perpetuating his name to the rising generation by picturing him as the hero of his time. In moderation this practice is to be commended but it would be unfortunate if children were left with the idea, even by implication, that he was a super-man in the sense that he could perform miracles.

Finally the United States Post Office Department, in the spring of 1940, put the crowning touch on all recent publicity by issuing a commemorative BURBANK stamp. Fifty millions of these three-cent stamps were sent out. They went to all first- and second-class post offices and to any others requesting them. This insured a wide distribution.

The BURBANK stamp was a part of what the Department called its "Famous Americans" series consisting of 35 intellectual leaders of America, five artists, five authors, five composers, five poets, five inventors, and five scientists. The others picked as scientists besides BURBANK were Dr. CRAWFORD W. LONG, credited with being the first physician to use ether as an anesthetic, Dr. WALTER REED of yellow fever fame, JOHN JAMES AUDUBON, the naturalist, and JANE ADDAMS of Hull House renown.

Within his group BURBANK was given the place of honor by placing his portrait on the three-cent stamp, which is far and away the most used stamp turned out by the Government. AUDUBON was assigned to the one-cent denomination, LONG to the two-cent, REED to the five-cent, and ADDAMS to the ten-centers.

Naturally there was much discussion about the entire list of "intellectual leaders of America," but one commentator [84] voiced the thoughts of many when he said: "Most controversy will be caused by the face of BURBANK upon a stamp. He is rated as a great gardener rather than a great botanist. Scientists by the dozen have equal reason for being honored on our stamps. JOSEPH HENRY, who ranks with FARADAY as the father of the electrical industry;

[84] WATSON DAVIS, Science, p. 10 of Supplement, February 23, 1940.

BENJAMIN RUSH, early physician of Philadelphia; ASA GRAY, the botanist; BENJAMIN SILLIMAN, early Yale chemist; JOSEPH LEIDY, E. D. COPE, and OTHNIEL CHARLES MARSH, great explorers of ancient and living animals; and WILLIAM H. WELCH, a great pioneer in medicine."

How are the names of notables secured for the honor of being placed on stamps? Who proposes them in the first place and what is the basis of evaluating their merits? Are the names chosen by a committee of persons qualified to judge achievement in the various fields of intellectual attainment? The Post Office Department gives this explanation:[85]

"Requests for [names to be used on] each new issue of postage stamps are received from so many different individuals in various sections of the country that the Department is not in a position to give credit to any one person for having offered the original suggestion. This applies to the majority of stamps in the Famous Americans Series, suggestions for which have been filed with the Department over a period of years. It was not until definite decision had been reached to provide a series of this character, about a year ago, that we began the research work incident to the selection of those entitled to recognition therein. No special committee was assigned to this task, the selections being based on the relative standing of the individuals in their respective fields which appeared to make them eligible for inclusion in the series. It was considered that a place should be provided in the group of scientists for LUTHER BURBANK in view of his noteworthy contributions to plant development."

[85] Letter to the author from RAMNEY S. BLACK, Third Assistant Post Master General, May 8, 1940.

XII

BURBANK THE INDIVIDUALIST

BURBANK seems always to have lived to himself and within himself. Even as a boy and very young man he was an individualist. While he was in school, which was up to about age eighteen or nineteen, he was not very different from other boys. Even when he took employment in his uncle's machine shop and later when he began working for his mother he appears to have cultivated the habit of reticence so far as his plans and thoughts were concerned. He did not physically withdraw himself from the life about him but in his thoughts he dreamed of a different life.

While gardening to support the family his thoughts strayed along unusual paths. For example, other boys, no doubt, had mused on the advantages of having types and varieties of vegetables that would mature a week or two earlier than usual, but young BURBANK did more than muse — he began to cross-pollinate promising varieties with the hope that some of the resultant hybrids might be earlier than their parents. And here he learned a great lesson — perhaps the first in his long career as a plant breeder — which was, that it is impractical to expect a new character, like earliness, to appear in the first generation of hybrids — that is, as the result of a single cross. However, his failures in this respect tended only to stir his imagination and stimulate him to further effort. Naturally his hard-headed, practical neighbors thought his experiments were a sheer waste of valuable time; and this failure to understand the boy caused him to retreat still further into his own world of introspection. To be rated as queer and treated as an eccentric character usually has a depressing effect, especially on a young person, but it is to BURBANK's credit that he had sufficient confidence in himself to stick to his ideals despite the discouraging attitude of his elders, but in doing so he had to walk alone.

It seems to me that this was the chief reason why he tore himself away from his childhood home and put a continent between himself and those who knew him. In his new home in California circumstances forced him to become a recluse. True, he could have found friends of sorts had he been willing to spend his idle time — of which he had considerable, at first — at the local poolroom or similar loafing places but he preferred the company of his own thoughts.

He perhaps always had an inferiority complex so far as the social graces were concerned but this fact never depressed him, because the deficiency, if it can be so designated, was more than offset by a confident feeling of superiority which at long last bur-

geoned and developed into arrogance. Small wonder then that he was awkward and ill at ease on chit-chat occasions but serene enough with inner grace when he could talk about his specialty.

When BURBANK became a world character he was besieged by visitors, many of whom he desired to see or was willing to give a part of his time; but there came a day when it became necessary to curtail even a selected list of callers and yet he was so self-centered and so jealous of his reputation that he could not, or would not, let any one help him. He never had a confidant or anyone he would trust to represent him. It has been told elsewhere how he would not keep an employee who felt that he was competent to entertain visitors; that was a task that he would entrust to no one. The establishment was a part of himself, and no one but he, himself, could tell the story or any part of it authoritatively and just as he wanted it to be told. It was wholly a personal matter with him — this telling — and he could not share it with anyone; no amount of pleading or scolding by those who loved him and had his welfare at heart — his mother, sister, or brothers — could break this resolution. He was truly a one-man institution.

Among BURBANK's legion of admirers there was much concern about the future of the great work he had begun. They wanted to know what provision he had made for its continuance. Most of his friends knew that he never had had a partner or anyone he was willing to confide in. Some of the bolder ones even put the question to him but history does not record his reply. Toward the end of his life the question was discussed verbally and in the press. Suggestions were made that this or that individual might carry on for him. I think he was favorable to the idea of converting his gardens into an experiment station under the auspices of Stanford University or the University of California. Both plans had been mentioned but no philanthropist came forward to provide the necessary endowment.

Just what BURBANK, wholly uninfluenced by close members of his family, would have done is not absolutely certain, but from the evidence that I have been able to gather I am convinced he hoped, through some arrangement, that WILL HENDERSON, a trusted employee, would carry on his work. Whether he envisioned HENDERSON's carrying on at the old stand, or elsewhere, is not clear. Apparently he never thought the problem through, or family opposition was too great, or something prevented his coming to a final decision, for he never made any definite commitment to HENDERSON, although he had done the unprecedented thing of giving him some foundation stock of certain plants which needed further improvement. This was only a few months before his death and the implication is clear that he favored HENDERSON somehow or in some manner to be his successor, and HENDERSON, apparently, could put no other construction on his acts and his general attitude toward him. However, on account of opposing influence or inability to make up his mind, nothing was settled. His final illness was brief and he passed away without leaving any

expression of his wishes. He simply bequeathed everything to his wife, a young woman, his former secretary, to whom he had been married for ten years.

It was late in April of 1926 when BURBANK died. Practically all the spring planting of seeds and bulbs had been completed. HENDERSON was discharged and nothing further was done except to get out a final catalogue of price quotations and book orders for the growing crop. All activity in the direction of plant improvement stopped suddenly and with finality, for with HENDERSON's departure no one was left who had the technical knowledge to do anything further.

Professionally speaking, BURBANK died as he had lived and his talents perished with him. He had no son or daughter to inherit his spark of genius and the only understudy he had who might have imitated his art with creditable brilliance was eliminated. The mighty oak was fallen and only the numerous acorns of his achievements were scattered over the earth for others to nourish and thus perpetuate his memory. Perhaps it is just as well that he did not have a successor who might have suffered by comparison, for there could be but one BURBANK. BURBANK, who came from a highly fertile family, was twice married but had no offspring. Sorrowfully and regretfully, people have asked me why. I have no answer.

XIII

BURBANK'S ETHICS

PREVIOUS reference has been made in these pages to BURBANK'S standards of conduct relating to right and wrong, particularly as applied to the sale of his products. It was stated that his outlook was ever that of the nurseryman and seedsman and that he followed the practices current among the dealers in plants and seeds of his time. He has been accused of overpraising his products and misrepresenting their value. And there have been hints and a few direct charges that some of the things he sold as products of a process of breeding carried on by him were, in fact, old varieties renamed or importations from some foreign country. Speaking in the abstract he was, at one time or another, and in some degree, guilty of all of these things but let us see how it works out in practice.

In the first place, I would ask the reader to pick up a catalogue of any nurseryman or seedsman of thirty to forty years ago who was engaged in business on a national scale and study the statements therein, particularly the descriptions and claims made for new things — novelties — and see how they compare with what was called the highly colored and over-enthusiastic descriptions and claims made by BURBANK. In fairness it must be said that our manner of life has taught us to expect the merchant to be enthusiastic about the virtues of his goods, and we are inclined to criticise and even to mistrust the salesman who has nothing good to say about his wares.

On the whole — from the standpoint of the buyer — the art of salesmanship has been greatly improved. It is now more subtle and less blatant, but exaggeration has not disappeared and probably never will as the public seems to like it. As applied to statements made in nursery and seed catalogues, exaggeration and even hyperbole are not only tolerated but they are expected and serve to leaven what otherwise might be tedious descriptions of new varieties; and the average person has come to look for them and to derive a pleasurable excitement from reading the sprightly descriptions. Few people are so trusting as to believe, *in toto*, everything they read, especially if they remember that the words were written by a salesman who is trying to sell them something. Laws have been framed to protect the artless but without much success.

Wide-awake florists, gardeners, and fruit growers are ever on the alert to obtain the newest things in their line but they are not deceived by the descriptions and claims set forth in the catalogues.

And neither are most amateur enthusiasts, although they are more credulous. Both take the bait: the former in cynical mood, the latter more in a spirit of hopefulness.

The search for new things, then, becomes a kind of game in which the player has good chances of winning, in some degree at least, for cultivated plants are constantly being improved. While many new varieties are disappointing, others turn out to be valuable additions to our nomenclature. The progressive florist, for example, cannot afford to ignore the announcements of new varieties lest he fall a step behind his competitors, but the fruit grower, on the other hand, must be more conservative as trees require several years to come into bearing and a mistake in planting is not so easily rectified as with annuals and other quick-maturing things.

Throughout most of his professional life BURBANK was in the nursery business from necessity rather than from choice. When he sold his general nursery to his partner in 1888 he thought he was out of the business of propagating and selling fruit trees and ornamentals and that, thenceforth, he would only have to produce something new, test it for a time, propagate a few plants and sell them all to one person or firm for a lump sum for cash — "lock, stock, and barrel", as he once said — and then proceed to produce something else. But things did not work out that way. Unable to sell some things at the first offering he had to hold them over and propagate anew — as fruit trees cannot be safely transplanted if too old — or he would sell only a half interest in something and try to dispose of the remainder at retail, himself, which involved more propagating. In a few years, by this process, he accumulated thousands of trees and other plants in nursery rows besides other thousands of seedling hybrids that were under test preparatory to being advertised for sale, the whole amounting to several acres of nursery stock. Thus he continued to be a nurseryman or a seedsman in spite of himself and remained one till the end of his life, but he never liked it. No wonder he fell for the blandishments of promoters when they offered to take over the selling end of his business!

Exaggeration in itself is not necessarily harmful or immoral. Employed in moderation it may become one of the spices of life. But carried too far a picture becomes a caricature and a plain statement of fact is warped into a falsehood. If the innocent purpose of an exaggeration is reasonably obvious it may enliven what otherwise might be a prosaic discourse. The all-important consideration is whether there is intent to deceive. BURBANK had great faith in his creations — for one thing, because he produced them. They were his babies and therefore had to be good, a not unusual attitude for the creator of new plants, mouse traps, or automobiles. And he praised them lavishly. But if we read his descriptions of new things carefully, the eulogies are directed as much at the creator as at the created. He was proud of the job and wanted the reader to share in his pride of accomplishment.

That many of his creations experienced an ephemeral existence did not dampen his enthusiasm in the least. I cannot find it in my heart to censure him for his over-praise of things that had little merit so much as I do the dealers who pushed them upon the public: things like the wonderberry, white blackberry, pitless plum, and spineless cactus.

BURBANK had no system of following up his new things once they had passed out of his hands. The time element made it impossible, just as he had no time for writing up complete records. He assumed that everything he sent out was valuable and let it go at that and turned to other things. What did his devoted sister or his enterprising secretary know about the horticultural value of many of his productions? And they helped him to write his descriptions. They simply took his word for everything and kept repeating statements that should have been modified. I for one do not believe that he meant to deceive.

The foregoing holds good for his fruits and flowers, but with some of his grains the available evidence appears to be against him. Some of the claims about his wheats, which were made in his literature,[86] are worse than exaggerations; they are said [87] by competent cereal authorities to be untrue, that most of them were old, discarded varieties that had been renamed, and the weight of the evidence appears to be on their side.

Toward the close of World War I, when there was great shortage of foodstuffs, especially bread, BURBANK introduced several new varieties of grains, four of them being wheat. He claimed [88] to have spent eleven years in producing them, presumably by a process of breeding. One of the varieties, the Quality, which he described as an early, hard, white wheat, was pronounced by cerealists to be identical with an Australian variety known as Florence. While the Florence had not been grown here commercially, it was well known to Experiment Station workers but was not thought worthy of introduction in this country. Be that as it may, Quality was widely planted in the Northern Plains States in the middle and late twenties as a spring wheat.[89]

In view of the great demand for high-yielding varieties with good milling qualities, BURBANK pushed the sale of this new

[86] BURBANK's 1918 New Standard Grains, BURBANK's Experiment Farms, Santa Rosa, California; and BURBANK's 1919 New Creations and Special New Selections in Seeds, pp. 27-29. BURBANK's Experiment Farms, Santa Rosa, California, U. S. A.

[87] Statements made to the author orally and by letter by J. W. GILMORE, Professor of Agronomy, a national authority on grain varieties, and Dr. F. N. BRIGGS, specialist in cereal breeding. Both of these men are responsible officials in the College of Agriculture of the University of California at Davis. Also Dr. CARLTON R. BALL, Principal Agronomist, U. S. Department of Agriculture, Washington, D. C. GILMORE was always friendly toward BURBANK; BALL considered both the man and much of his output to be unreliable; while BRIGGS, who belongs to a younger generation, is neutral in his attitude toward the man and his work except in this particular connection.

[88] BURBANK's 1918 New Standard Grains, p. 3.

[89] United States Department of Agriculture. Technical Bulletin 459: 53, 1935.

variety and recommended its planting as a patriotic duty. The price was $5.00 per pound, or at the rate of $300.00 a bushel. Considerable feeling was aroused because BURBANK at the time was a member of a national committee [90] that was supposed to give competent, disinterested advice about what to plant in order to increase the food supply.

BURBANK often imported plants from foreign countries, usually novelties or little known things, and introduced them here under their botanical names or names of his own or used them as breeding stock. What actually happened in the case of the Quality wheat, at this late date, can only be conjectured. While it is possible that he may have produced a hybrid that was identical with Florence, it is very improbable. Also he could have received a quantity of wheat containing an admixture of Florence wheat; and after planting it, he might have selected the most promising stalks, which turned out to be Florence, but not being acquainted with that name, called it Quality. However, these possibilities are somewhat far-fetched and, I fear, improbable. Another possibility is that he may have obtained a sample of Florence wheat from one of the Experiment Stations in this country, as a number of them were experimenting with it before the outbreak of World War I.

In BURBANK's time, it was not unusual for a nurseryman to rename an old variety of fruit. Sometimes this was done through ignorance or inadvertence, but sometimes deliberately. Scion wood of several varieties might be received from an eastern state for trial on the Pacific Coast. Somewhere during the nursery period a name might be lost or displaced and when the unknown variety came into bearing and was found to be desirable, the nurseryman, not knowing its name, gave it one of his own.

To speculate further, a fruit might be found growing in a farmer's garden; no one knows its name or whether it ever had one. It is taken for a chance seedling and given a name. To this day there are many such trees growing in California and every year fruit is sent to the College of Agriculture of the State University for identification. Most of them are found to be old or obscure varieties while others are pronounced to be seedlings. Throughout the history of horticulture many valuable varieties have been discovered as bud sports and chance seedlings.

---

[90] The following printed notice—as a pasted-in insert—was sent out with BURBANK's catalog entitled "*Burbank's* 1918 *New Creations and Special New Selections in Seeds*:"

To Inspire Planting of One Million Food Gardens

NATIONAL EMERGENCY FOOD GARDEN COMMISSION

210-220 Maryland Building, Washington, D. C.

CHARLES LATHROP PACK, President; PERCIVAL S. RIDSDALE, Secretary

LUTHER BURBANK, California	Dr. JOHN GRIER HIBBEN, New Jersey
Dr. CHARLES W. ELIOT, Massachusetts	EMERSON MCMILLIN, New York
Dr. IRVING FISHER, Connecticut	CHARLES LATHROP PACK, New Jersey
JOHN HAYS HAMMOND, Massachusetts	A. W. SHAW, Illinois
FAIRFAX HARRISON, Virginia	Hon. CARL VROOMAN, Illinois
Hon. MYRON T. HERRICK, Ohio	Capt. J. B. WHITE, Missouri.

Hon. JAMES WILSON, Iowa

No horticulturist has the skill to recognize every variety of a given fruit that has ever been grown in this and other countries, so the practice of giving names to unknown things that are found cannot be indiscriminately condemned, for they might be something new and prove to be valuable. Conspicuous examples, to mention only two, are the Delicious apple and the Concord grape.

BURBANK may have imported a few things — chiefly ornamentals — from far-off countries and given them names of his own; it would not have been unethical if he had, but I do not know of any authentic case of his having done so with a fruit. However, he came pretty near it when he brought over the Burbank and Satsuma plums, which may have borne variety names in their home country of Japan.

As related earlier, something seems to have happened to BURBANK after he took back what he could salvage from the wreck of the Company failure. He was not only a sadder, wiser, and much chastened man, but his ideals had undergone a change. He now did less research and more and more seemed to be out for the money. He continued to experiment with bulbs but appeared to concentrate on having things sent to him by collectors from Chile, Australia, and other places, and to pick up oddities and novelties at home. The large collection of fruit tree seedlings in his Sebastopol orchard, seven or eight miles from Santa Rosa, continued to yield a new fruit now and then but his seed business was gradually monopolizing his time and facilities. As most of the things he was now growing were annuals, his routine became a matter of sowing, reaping, and selling. Rather suddenly he became a merchant instead of an experimenter. This was a new development in his life. Never before was there any real evidence that he was more interested in gain than in reputation, that is, fame as a plant breeder.

Then he decided to get rid of his experimental orchard. In a letter to one of his old customers[91] on June 2, 1924, he wrote: "You will notice by enclosed circular that I am offering my Sebastopol place for sale as my seed business has grown to such enormous proportions that I cannot well attend to both." No acceptable bids being received for the orchard he, perforce, had to keep it. New varieties continued to show up which he considered worthy of being introduced, but instead of propagating them himself as of old, he farmed out that task to the Armstrong Nurseries of Ontario, California, and this arrangement continued until his death in 1926. He was definitely out of the nursery business after about 1921 or 1922.

After becoming a seedsman BURBANK added nothing to his reputation as a plant breeder. During his lifetime he had recognized two roads that he might follow — one leading to fame, the

[91] H. E. V. PICKSTONE and Brother, Limited, Simondium, Cape of Good Hope, South Africa. (This company kindly loaned me their complete file of correspondence with Mr. BURBANK covering a period of nearly thirty years. Author.)

other to wealth. He has told us many times that he deliberately chose to disregard profit if it interfered with the attainment of his ideals — the improvement of economic plants and, by inference, the attainment of fame. Selling his profitable general nursery business in 1888 supplies proof of his sincerity. That the course he then decided to follow proved also to be moderately profitable is beside the case, for he could not know that it would be so, though cannily he may have foreseen such an outcome.

The point is that he continued to be consistent until the last few years of his life when he definitely forsook this road for the one leading to profit. We have his own word for it. Why this abrupt change in his ideals we do not know for certain. Evidently there was a sudden need or desire for money. Could it be that he resolved to capitalize his fame — the magic of his name — and the faith people had in him, by going into the general seed business and using his own productions as leaders or lures to attract customers for the standard or common varieties which he could purchase at wholesale or grow with little effort and expense?

His change in policy began to be noticeable in the publications he issued following the failure of the Company in 1915. More and more seeds were offered and less and less bulbs and woody plants. This reversal of policy stands out boldly when it is recalled that his real renown was based upon his researches with fruits and bulbs and not with plants that are propagated from seeds. It was in the early twenties he announced[92] that he had gone out of the nursery business and was giving his full time to growing seeds — flower seeds predominating. The seed business grew rapidly. At first it was announced that all his seeds were "new creations." Then there were two lists, the "new" and the "standard," the last being common commercial varieties not originated by him. Finally there was only one list containing both old and new kinds with no directions for determining which was which. Worse still, certain items were definitely stated to be BURBANK originations, while the reader, unacquainted with varieties, was left to infer that the others were, too, although nothing was said about their origin. The inference was strong that all were his, but he actually made no such claims. All of which is unlike the BURBANK we knew previous to 1916 or 1917.

One sound reason for his change in policy was that he needed money to recoup his recent losses. But, in view of his previous record, this explanation seems inadequate. Apparently as early as 1916 something mundane had happened to becloud his mission, to dull his Messiahship. This was the year he acquired a young wife, a woman with understandable ambitions. Could this have been one of the reasons for his change in outlook? The assumption would seem reasonable. There had, also, been a cabinet change: his faithful sister now had a home and family of her own and was no

---

[92] Special circular entitled "The BURBANK thirteen-acre Goldridge Experiment Farm. Inventory, January 1, 1924."

longer his chief adviser. Sentiment had to give way to realities. Fame he apparently took for granted — something already attained — but money had to be worked for, and no nonsense about it.

BURBANK's moral standards were such as had been impressed upon him by a strict father and an upright New England mother. To the best of his ability he observed all the rules of Decalogue. He was personally honest, paid his just debts, and honored and protected his widowed mother throughout her long life. All his life he abhorred drinking and carousing. He did not covet his neighbor's wife, and he was entirely free from philandering. But with all these convictions he was remarkably tolerant of other people's manner of life. One evidence of his perennially youthful mind was that he did not sour with age and disappointment — that is, not visibly. If anything, with changing times he became more tolerant but at the same time I am persuaded that he also became cynical. Faithless business associates and inconstant friends brought about this change in his fundamental makeup. During the last ten years of his life he had troubles enough to sear a man's brain; they continued up to the day of his passing, but through it all he retained his sense of humor. True to his New England heritage, he did not air his troubles. He pretended not to read, to hear or to see, but one who knew him well and was close to him tells me that "nothing that went on escaped him; that he was the most observant man and the quickest to draw conclusions" of any man he ever saw. Putting into practice his philosophy of life, he simply ignored what he could not help.

XIV

BURBANK'S RELIGION

IT MIGHT be said that BURBANK was a religious man without being a religionist. He respected christianity and liked to attend church services. Apparently he sought something in the church which he never could quite find. Brought up by church-going people — especially by a religious but liberal mother — it was only natural that he should feel the urge to observe some of the forms of religion. While he may have attended church partially from habit and because it was the thing to do, I am convinced that there was some deeper motive in his nature that impelled him to incline toward the church. His church attendance was not prompted by motives of social advancement or business prestige, and I have no evidence either that he went as a conventional worshiper. He certainly did not regard himself as a sinner in need of periodical cleansing. He was never humble and he was never meek and he was not a prayerful man. He liked to hear the scriptures expounded but the discourses were liable to leave him cold and discontented rather than ecstatic.

Then why did he go to church, at least at first, with considerable regularity? My explanation or guess is this: as a follower of DARWIN, his childhood's faith and belief had been upset and it required many, many years for him to acquire a philosophy to replace them. In the meantime he went as a matter of habit and to please his mother. As a young man in his teens and early twenties the thunders of disapproval against DARWIN from every pulpit in the land must have left him troubled in spirit, for there was a strong spiritual side to his makeup. Having fully accepted DARWIN'S naturalistic explanation of the origin of species in the plant and animal world, as against the theistic origin taught by the church, he did not try to reconcile the two explanations of the source of life. Being a strong believer in organic evolution he accepted this teaching as his religion. At this point he might have become an out and out infidel, but he did not. Far from it. His childhood faith had been uprooted but, like the weeds in his garden, some of the remnants insisted upon growing again. All of the roots of his faith had not been destroyed; like the regenerated weeds, he did not cultivate them but they refused to die.

When he went to California he became a church attendant, joined the Baptist church and became, for a time at least, a regular communicant. But spiritually he was not satisfied. Actually he was in rebellion against the forms of the church rather than its substance. Creed and dogma he could not abide, and the oratorical

pyrotechnics of the old-time revivalist type of minister left him cold and disillusioned.[93] He craved a religion of brotherly love uncomplicated by tenets incapable of satisfactory proof. So he left the church he had been attending and became a follower of a "renegade" minister from the same church — Rev. J. WILLIAM HUDSON, who became a Unitarian. And this was the faith that he was nearest to for the rest of his life. He selected a Unitarian minister, the Rev. CALEB S. S. DUTTON, pastor of the First Unitarian Church of San Francisco, to officiate at his marriage in 1916, and this same man had a part in the memorial services in 1926 after he died. His old friend, H. W. SLATER, wrote at the time that "BURBANK was a Unitarian as was his father before him",[94] which, strictly speaking, was incorrect as neither formally belonged to that church.

---

[93] BURBANK evidently attended different churches when a young man. While details of events that transpired in the early eighties are now not always clear in the memories of persons yet living, those I have talked with are in substantial agreement—that he attended both the Baptist and Christian churches and later became identified with the Unitarian faith. Three versions are cited: Prof. J. E. CHENOWETH of Bakersfield, California, in a personal letter, writes under date of August 9, 1939:

"So far as the church situation was concerned in Santa Rosa, due to the lapse of time, my memory is a little hazy on one or two points. My own affiliation was with the First Christian Church, and at that time the pulpit presentations were very much of a 'Hell-fire-and-damnation' nature. Ranting and snorting were considered to be good forms. There was a change in the pastor, and the new man who came in was Reverend J. WILLIAM HUDSON. He was of a different type. He spoke of weaving the warp and woof in the pattern of life. He described the work of SAVONAROLA. He forgot to say very much about 'Hell-and-damnation'.

"As a consequence, the elders proposed a change of ministers. There was a schism in the church. A number of the congregation organized the second Christian Church, and it was to this group that I turned, while my mother remained in the original church. LUTHER BURBANK attended this church and he passed the collection plate down one aisle, while I passed one down the other.

"I still have a very vivid mental picture of LUTHER BURBANK and the manner in which he passed the collection basket. About that time I was graduated from high school and moved to San Francisco and J. WILLIAM HUDSON was called East to an important pastorate. So, it is quite possible that a Unitarian minister may have invited his attention as did the keen intellect and the brilliant presentations of the young J. WILLIAM HUDSON."

Dr. D. P. ANDERSON of Santa Rosa, in a personal letter under the date of August 11, 1939, states:

"As you probably know, BURBANK attended the Baptist Church—the one that had the famous building built from a single tree, a California redwood—when he first came to Santa Rosa. He quit it because of their narrow views and so did I. He never attended church after that except the Unitarian which sprang up under a Mr. HUDSON and disappeared when he left. I understand while not a member [that] BURBANK attended occasionally."

Senator HERBERT W. SLATER, a newspaper man of Santa Rosa, writes, September 2, 1939:

"Mr. Burbank of course was not an unbeliever. I heard him make declarations, long previous to the religious hubbub which sought to brand him as an unbeliever, in which he pronounced his belief in God. . . . I remember Mr. BURBANK used to attend, how often I don't know, the Peoples' Christian Church here, of which Dr. J. WILLIAM HUDSON was pastor after he had seceded from the First Christian Church."

[94] Santa Rosa Press-Democrat, Santa Rosa, California, April 11, 1926.

In a strict, ecclesiastical sense, BURBANK was not religious and not even a Christian but in the eyes of the world he was both. So far as I know, he made no attempt to classify his religious beliefs or convictions but others attempted to do so for him and he never rebuked them. However, it was mostly after his death that organized agnosticism came forward to claim him as its own, their last act being, to put on quite a "show" at his funeral.

Several months before his death a controversy arose regarding his religious beliefs. He gave an interview to a news writer [95] who branded him as an infidel. Later he delivered a lay sermon in the First Congregational Church in San Francisco [96] and attempted to clarify his ideas about religion, in which he outlined his philosophy of life; but this only made matters worse and he was denounced from pulpits throughout the land. Less than two months later he died and, according to an arrangement he had made two years previously, a prominent free-thinker, Judge B. B. LINDSEY, delivered the funeral oration and finally at the graveside WILBUR HALL read the famous eulogy that ROBERT G. INGERSOLL pronounced over the body of his brother in Washington, D. C. in 1879.[97] LINDSEY's address was published in pamphlet form [98] and widely circulated. Besides the address and how he came to deliver it (a pact between himself and BURBANK), the pamphlet contained an article by MAYNARD SHIPLEY, a militant agnostic, entitled "LUTHER BURBANK's Last Rites", and a statement by WALTER W. LIGGETT (evidently a free-thinker propagandist), entitled "Baptists Lie About LUTHER BURBANK."

SHIPLEY thus described his arrival at the burial scene beneath the spreading branches of a cedar of Lebanon tree in the BURBANK yard: "Save for a few minutes only, at the moment of greeting, there was an entire absence of gloom. Voices broke for an instant, it is true; but there was no funereal atmosphere; no black crepe or black dress was in the house; there were no sepulchral tones, no sobs. Mrs. BURBANK was dressed in a light striped material; her friend and companion, Miss GLADYS KENNEY, wore white." A perfect infidel's funeral carried out to the last detail in the best Ingersollian style. Obviously planned and executed by experts with an eye to the cause! WILBUR HALL, "an old friend of the family" and BURBANK's biographer, "was in charge of the private services" at the graveside. LINDSEY denies all knowledge [99] of the nature of the burial service that was to be held so it must be concluded that BURBANK did not plan it as he did the funeral oration.

---

[95] EDGAR WAITE, San Francisco Bulletin, January 22, 1926.

[96] San Francisco Bulletin, February 1, 1926.

[97] Santa Rosa Press-Democrat, Santa Rosa, California, April 15, 1926.

[98] "Address at the Grave of LUTHER BURBANK", by Judge BEN B. LINDSEY. Little Blue Book No. 724, Haldeman-Julius Publications, Girard, Kansas.

[99] Personal letter to the author, December 18, 1939.

The burden of Mr. LIGGETT's contribution was a refutation of an editorial published in a religious journal[100] to the effect that BURBANK recanted on his death bed. He faithfully ran down the story and submitted proof that there was nothing to it.

Although a practical Christian and leading a Christian life, BURBANK was not an orthodox Christian. In playful mood he may have referred to himself as an infidel or even as a pagan but such remarks must not be taken too seriously as he was given to making extravagant statements. As he grew older he devised a philosophy of life that was all his own. His code of morals was all that any churchman could ask for. He was not opposed to the church and never tried to tear it down. If he did not believe in it he certainly was not in the least a propagandist against the faith — was far from being a militant agnostic. As a matter of fact, he had no grievances against the church itself but against what he considered its narrowness and intolerance. Morally speaking he led a blameless life. Few men came as near to observing the Ten Commandments. A teetotaler by choice and conviction all his life he preached against the use of tobacco and spirituous liquors. Absurdly enough, during the religious controversy, a handful of fanatics in the Sonoma County Women's Christian Temperance Union, of which he was an honorary life member, tried to humiliate him by requesting his presence at a mass meeting called for the purpose of praying for his soul.[101] He sent his regrets but the incongruity of the situation appealed to his sense of humor and caused him many a wry smile.

To preach against the use of alcoholic beverages in a community where wine-making was a major industry required considerable courage but he could not compromise on matters of principle. Still, on occasion, he could laugh at himself. A story is told[102] that when approaching his seventy-fifth birthday, in waggish mood, he boasted that he would celebrate his natal day by taking his first drink of wine, remarking that he "guessed he was too old to acquire the habit." But alas, he was slightly ill that day and did not feel like carrying out his little joke. Too bad the reporters did not hear of the incident or they would have made him go through with it to the accompaniment of clinking glasses and clicking cameras — even though it killed him — as the story would have been good for several columns at so-many dollars per, and perhaps a promotion for the enterprising newsmen — for this was the manner in which he was exploited by space writers.

At this point I feel justified in interjecting a mention of what might be termed a morbid confession story, by a troubled soul, that appeared in a popular magazine a few years ago. The story was entitled "Murder by Print. LUTHER BURBANK's death through a newspaper-made mass hysteria." The author[103] convicts himself

[100] The Crusaders' Champion, June 11, 1926.
[101] San Francisco Bulletin, February 26 and 27, 1926.
[102] Related to the author by Mrs. BURBANK in 1932.
[103] FRANK PIAZZI, Coronet, pp. 170-172, May, 1937.

of being one of the "murderers." He tells about living across the street from the BURBANK garden and throughout his childhood knowing BURBANK by sight. As a high school boy he became acquainted with BURBANK and was the recipient of many kindnesses at his hands. After finishing school PIAZZI became a reporter for a local paper and at the same time served as correspondent for the United Press. In the latter capacity he was asked by the *Oakland Post-Enquirer* to interview BURBANK "on his beliefs on immortality and the hereafter" to be used "as a companion piece to a similar interview with HENRY FORD then appearing in the *Cosmopolitan Magazine.*"

"To my questions he gave simple, clear, interesting answers." The story appeared next day and was picked up by the service wires and broadcast throughout the nation. The mail deluge came a few days later. Other correspondents, with cameramen, arrived daily. Then he delivered his fateful address in a San Francisco church and tried to explain, but the newspapers branded him as an atheist. "Here was a highly controversial topic, one good for weeks of headline exploitation, with an international figure in the spotlight. . . . Editors incited the riot. The journalistic pack had got the scent. And LUTHER BURBANK was the harried prey. . . . His telephone rang night and day. Reporters camped on his doorstep. Telegrams poured in. The mail increased horrifyingly.

"He was questioned, accused, villified, libeled, lampooned, and execrated. One city editor forced me, under violent protest, to go and ask the poor plant man if he ever got down on his knees and prayed to God. BURBANK's answer — I shook his hand when he told me it — was: 'Tell him it's none of his damned business.' Public opinion, fanned by sensation seeking papers, turned against him. He suffered a breakdown. He was confined to his bed under the care of a doctor. No one could see him. This, climaxing the crescendo of hysteria that had swept the nation following his pulpit address, was like an inevitable third act. The newspapers and the wire news services waited breathlessly for every bulletin as Mr. BURBANK's life hung precariously in the balance. Thirteen minutes after midnight, April 11, 1926, LUTHER BURBANK died — victim of a chance phrase publicized by the American Press."

If BURBANK was an infidel he certainly was not proud of it. In his wildest statements he never condemned the biblical characters nor the Bible as a whole as being an unfit document for children to read. Neither did he condemn the church as an organization. Possibly he looked upon it as a moral institution only — a guide for the living but not something to die by. He believed in intellectual freedom but certainly no one has reported that he ever expressed admiration or even tolerance of free love or trial marriage. He would have regarded both of these practices as highly immoral.

Could he have been an infidel and still retain his moral code? I do not think so. I think he was frankly skeptical regarding the Bible story and all its pronouncements and preferred to accept the

naturalistic explanation of life as his guide. But beyond this he did not go as he was not a profound logician, was not schooled in formal philosophy, and was not especially well read in any direction if one is to judge by the books in his personal library, except the works of CHARLES DARWIN — *Origin of Species, Animals and Plants Under Domestication,* and *Cross and Self-Fertilization,* together with the standard books on taxonomic botany of his time. These latter however were mostly books of reference.

According to BURBANK's historian,[104] a somewhat biased witness — biased in favor of classifying him as an infidel — who spent a few months with BURBANK just previous to his death, says of him: "LUTHER BURBANK believed neither in heaven nor in hell, in the transmigration of souls nor the translation of the body. . . . For him the 'life everlasting' was a phrase — a figure of speech. He had as little curiosity about the unknowable as any man who ever lived, and considerably less concern with the future. For him life overflowed with wonder, beauty, delight, and the work he found committed to his hand, and whether anything was to go on for him or not interested him not a whit. Sufficient unto the day was the heaven thereof."

On the other side of the ledger we have the writings of HARWOOD,[105] CLAMPETT[106] and his own ghost-written book.[107] They all spread the mantle of Christian charity over him and accepted him as a religious man of a special variety. HARWOOD gives this as BURBANK's creed: "My theory of the laws and underlying principles of plant creation is, in many respects, diametrically opposed to the theories of the materialists. I am a sincere believer in a higher power than that of man. All my investigations have led me away from the idea of a dead, material universe, tossed about by various forces, to that of a universe which is all-force, life, soul, thought, or whatever name we may choose to call it. Every atom, molecule, plant, animal, or planet is only an aggregation of organized unit forces held in place by stronger forces; thus holding them for a time latent, though teeming with inconceivable power. All life on our planet is, so to speak, just on the fringe of this infinite ocean of force. The universe is not half dead, but all alive." If this was written by BURBANK, and I think it was, it bears a striking resemblance to the views of THOMAS A. EDISON, the inventor, expressed a few years before on the same subject.[108] "I believe our bodies are composed of myriads and myriads of infinitesimal entities, each in itself a unit of life, which band together to build a

[104] WILBUR HALL.

[105] HARWOOD, W. S., BURBANK's Creed. Century Magazine, New York, April, 1905.

[106] CLAMPETT, FREDERICK WILLIAM, LUTHER BURBANK, Our Beloved Infidel; His Religion of Humanity. Macmillan Company, New York, 1926.

[107] Summarized in a little book, "My Beliefs—LUTHER BURBANK," with an appreciation by CHARLES F. RIDEAL, who apparently was the ghost writer although some of the statements are undoubtedly BURBANK's. The Avondale Press, New York. No date.

[108] LESCARBURA, AUSTIN C., EDISON's views on life and death. Scientific Monthly, October 30, 1921.

man. . . . The entities are life. . . . The entities live forever. You cannot destroy them, just as you cannot destroy matter. . . . What we call death is simply a departure of the entities from our body." BURBANK was a great admirer of EDISON and perhaps a bit envious because, while both were "wizards" in their own right, EDISON was accepted without reservation as a scientist while BURBANK was not. EDISON visited BURBANK in Santa Rosa in 1915, and they were much photographed together and EDISON paid him many heart-warming compliments. It is quite conceivable that he used EDISON's thoughts to describe his own state of mind. He was not averse to allowing others to do his phrasing for him as he wrote with difficulty on abstruse subjects.

BURBANK must have seen the interviews given by EDISON on his religious beliefs as they appeared in *Cosmopolitan Magazine* May 20, 1920, as well as in *Scientific Monthly* for October 30, 1920, and Freethinker organizations gave them much publicity.

CLAMPETT is even more vague in his assertions but with skillful strokes he paints a picture of the Christlike qualities of BURBANK without committing himself specifically as to his religious beliefs.

Both CLAMPETT and HARWOOD, as churchmen and BURBANK historians, seemed to feel it incumbent upon themselves to play up their man as a Christian character. From their viewpoint, no other part would suit him as they were portraying him as a kind of mystical hero with super-human attributes and their appeal was to the lovers of the beautiful and worshipers of the wonderful.

CLAMPETT stressed BURBANK's affection for children and his universal love of humanity. Here he was on safe ground as BURBANK was a veritable Santa Claus to the school children of his town and he was never too busy or too preoccupied to speak a kind word to every tot that came his way.

In his helplessness and exasperation at trying to explain his position to the howling multitude of fanatics during the religious controversy and realizing the futility of trying to reason with unreasonable beings, he fell back upon what was to him his last line of defense — repeating over and over what he had said before: "I love everybody; I love everything. I love humanity; it has been a constant delight during all my years of life; I love flowers, trees, animals, and all the works of nature."[109]

Being desirous of learning what churchmen in general think of BURBANK, clergymen of sufficient note to be included in *Who's Who in America* were contacted throughout the United States and asked several questions, one of which touched on his religious beliefs. The following excerpts are culled from the mass of replies:

"Held mystic views. Believe him to be an agnostic."

"Held practical views. Believed in God and much of the Christian teaching."

"Deeply regret that he lost the spiritual vision [which he] held in former years."

[109] See Footnote 107.

"Reports that he was a non-believer [were] never properly confirmed. Deplorable if true."

"No matter what may have been his religious convictions, he left a fine legacy of temporal blessings."

"Would have been twice as valuable to science if he had believed in God."

"Was quite unorthodox; declined to accept things as they are and went out to make them as they ought to be, as he saw it."

"A naturalist in religion; not conscious of revealed religion."

"Sorry [that] statements regarding his lack of faith have gone abroad, for he could not have done what he did if he had not believed in God as the author of law in the natural world."

All of these men knew BURBANK only by reputation which they gained by reading "books, magazines, and newspapers." Most of them seemed to be well posted on the religious controversy that raged in 1926 but only two or three, from centers of Fundamentalism, evidenced any signs of bitterness. The majority frankly regarded him as a skeptic, some cheerfully, others regretfully, a few with scorn. Home folks, that is, residents of Santa Rosa, who were acquainted with his idiosyncrasies refused to believe that he was irreligious despite anything he might say. This might be attributed to wishful thinking but it is more likely that his daily life was a refutation of his own words. Here is the way the situation is summed up by the Rev. THOMAS BEVERLY MARSH,[110] pastor of the First Baptist Church of Santa Rosa, who never saw BURBANK, was a comparative stranger in the town, and therefore had to depend upon what people there told him when he made extensive inquiries:

> Mr. BURBANK was not a member of the Baptist Church, but he was known by those who were closest to his life as a very religious man. He had a kindly interest in the various churches of the community, and he was devout in his personal life. During the later years of his life, his interest in horticultural experiments appeared to engross his attention and, owing to this, his attendance at church services grew less frequent.
>
> His personal friends in Santa Rosa regret very much the publicity given to a statement he made to the press regarding his belief in Immortality. They feel that this casual statement of a recognized expert in one department of science in another realm (that of Religion where he did not pose as an expert) has been magnified out of all proportion to its importance in the mind of Mr. BURBANK. His friends here seem to be quite persuaded that he retained his religious convictions to the end.

Finally, BURBANK undoubtedly led a Christian life according to the standards of the multitude but with equal certainty he did not practice the forms or ceremonials of religion. He could be claimed both by the pro's and the con's. In fairness it should be stated that he did not claim to be an "all out" believer in the Bible as a piece of inspired literature — in fact, he rejected the idea — but he never went out of his way to attack the faith of others. His quoted sayings about religion are of little value in arriving at the truth of his convictions, because it is sad but true that his self-assurance led him to talk too much about things that he knew little about. Since he was extravagant of speech, a chance remark might be expanded into a sensational story. And he loved this sort of publicity, at least until it got out of bounds.

[110] Personal letter to the author, September 26, 1939.

It is too bad that he did not write a connected, authentic account of his life. Unfortunately there were only too many persons ready and willing to take the job off his hands, and being an extremely busy man he let them do it, well knowing that they would go the limit and say things that he would not say himself, and in more catchy phrasing than he was capable of employing; and I have no evidence that he ever protested their statements. Reason, he loved hyperbole and exaggeration. But with all his goodness of living he was a skeptic and had his honest doubts about the Bible story.

XV

BURBANK'S FORAY INTO SCIENCE — THE CARNEGIE GRANT

FOR A TIME, in his middle fifties, BURBANK became a conventional scientist in spite of himself. This brief incursion into a new manner of life — to him a sort of regimented existence — occurred in 1905 when the Carnegie Institution of Washington decided to provide him with a cash subsidy in the belief that valuable information on the science of plant breeding was being lost because he, working alone, was unable to keep careful record of what he was doing. More than once he had complained that State and Federal agencies were expending large sums on research while he was left to run a private experiment station that benefited the public far more than it did himself. He said it was unfair but did nothing further about it. As usual, though, his friends sprang to his aid. They soon learned, however, that under existing laws and regulations, public funds, State and Federal, could not be used to support a private enterprise, no matter how meritorious it might be. Then they began to look for a private benefactor.

About this time the Carnegie Institution was very much in the public eye. Founded by ANDREW CARNEGIE in 1902, it was reincorporated by an act of Congress in April of 1904. The initial endowment by CARNEGIE amounted to $10,000,000 but later this sum was more than doubled. It was declared that "the objects of the corporation shall be to encourage in the broadest and most liberal manner, investigation, research and discovery and the application of knowledge to the improvement of mankind."[111] Provision was made for a Board of Trustees (not less than 27 nor more than 30) which was given power to elect officers from its membership and to exercise complete management and control of the activities and affairs of the Institution.

Mr. CARNEGIE himself named the first Board of Trustees and while a great majority of the members were residents of the extreme eastern part of the United States at least four were former residents of California or had a sentimental interest in that state. Three of them, by virtue of their position on the Board, wielded great influence on the policies of the Institution. DANIEL C. GILMAN, President of the Institution and Chairman of the Executive Committee of the Board of Trustees, an early President of the University of California, had lived in that state for three years; D. O. MILLS, a pioneer banker and merchant of San Francisco, was an influential member of the Finance Committee (later chairman);

[111] Year Book No. 1, 1902, Carnegie Institution, Washington, D. C.

and Judge WILLIAM W. MORROW, for twenty-seven years a member of the Board of Trustees, lived for many years in Santa Rosa and was married there. LYMAN J. GAGE, ex-Secretary of the Treasury, was a member of the Finance Committee and, while not originally hailing from California, may have had more than a passing interest in the state as evidenced by his going to San Diego (in 1909) to be married and making the place his home for eighteen years thereafter.

As early as 1904 the Carnegie Institution was widely known for its large endowment and generous benefactions to science. It was perfectly logical that BURBANK's friends, after failing to obtain financial assistance from public funds, should turn to this new dispenser of largess. The story of how, or by whom, BURBANK's case was brought to the attention of the Trustees of the Institution never has been told, but it was common rumor at the time that "California should have its share" of any moneys that might be available for the assistance of struggling men of science and that great pressure to this end was being brought to bear upon the Trustees by "the California members" and others. And they were successful in being heard. The Institution voted BURBANK a cash subsidy of $10,000 a year. This action brought a storm of protest from institutional scientists. They criticised the Carnegie Institution on the ground that BURBANK was not a scientist and that he could show no scientific results from his experiments.

In response to this criticism the Institution promised to send a competent man to collaborate with BURBANK and see that he kept faithful records and followed conventional methods of procedure. The first installment of $10,000 was given to BURBANK in 1905, but a year or more elapsed before a satisfactory person could be found to supervise the project.

At the end of the fiscal year, October 31, 1905, formal reports on all projects receiving subsidies from the Foundation were required. BURBANK's project for the period, "Grant No. 221," appears to have been duly reported on, but must have been re-written as the discussion does not sound like BURBANK at all, although the claims as to numbers of plants involved are truly Burbankian. The report, as published, follows:[112]

"The experiments under way are the most extensive ever carried out, but from their very nature valuable results, either practical or scientific, can not be obtained at once. The pursuit of long periods of intensely careful and most accurate observations on a broad and comprehensive scale is the only course whereby results which will stand the test of time may be obtained. The laboratory and small field experiments of the past have never included enough species under study at the same time, and it has been impossible to draw general conclusions safely, as the different tribes and species of plants have each a slightly different story to relate. Very strong points are brought out by studying the results of these vast experi-

[112] Carnegie Institution of Washington, Year Book No. 4, p. 125, 1905.

ments, and much valuable material for thought will undoubtedly be found in the scientific account of the experiments.

"Some of the experiments which have been carried on for the last 15 to 38 years are just coming to fruition. A partial list of the plants upon which work is now progressing includes 300,000 new hybrid plums, the work of the past 25 years in crossing about every known species, and about 10,000 seedlings of the year's growth; 10,000 new apples; many thousand peach and peach-nectarine crosses; 8,000 new seedlings of pineapple quince; 400 new cherry seedlings; 1,000 new grapevines; 8,000 new hybrid chestnuts, crosses of American, Japanese, Chinese, and Italian species; 800 new and distinct hybrid walnuts, crosses of American black, Sieboldi, English, Manchuria, butternut, and others; many thousand apricots and plumcots; 5,000 select, improved, thornless 'Goumi' (Eleagnus) bushes; very numerous other fruits in less numbers, and 10,000 new, rare, hybrid seedling potatoes.

"For the past eight years Opuntias and other cacti have been secured from all parts of the world. Selections have been made and crossed and thousands of hybrid seedlings raised, some tender or hardy or gigantic or dwarf; some bearing gigantic fruits in profusion and other small ones of exquisite flavor. Some large groups have been developed which produce enormous quantities of nutritious food for all kinds of stock and poultry. This work promises well for science and economics. Perhaps the next in importance are the experiments on grasses and forage plants. Some new ones of great value are being produced and some of rare scientific value in the study of heredity and variation."

It is evident that the BURBANK cause had been thoroughly sold to the Institution and great things were expected from the venture. In commenting upon the activities of the Foundation for the year, President WOODWARD (who succeeded GILMAN in 1904) said, with reference to Grant No. 221:

"The horticultural experiments and the remarkable achievements of Mr. LUTHER BURBANK are well known in a popular way, though it must be said that the more important aspects of his work remain yet to be interpreted to men of science as well as to the interested public. Owing to the impracticability, during the past year, of securing the services of a trained biologist, the preparation of a scientific account of the ways, means, methods, and results of Mr. BURBANK's work has been delayed. He has continued his experiments, however, as related in his report, and it is hoped that the necessary arrangements for securing the scientific account of his work contemplated by the Board of Trustees will not be long deferred. *Little short of five years will be required for this work if it is done thoroughly well.*"

The italics are mine. The sentence deserves emphasis because those seventeen words constitute the only reference I have been able to find that mentioned any specific period the benefaction was expected to run. The President was a man of science and therefore cautious. He doubtless thought, even hoped—if he allowed

his imagination to dwell on the possibilities as represented to him—that the project might run for a long time, but could see no reason for committing himself beyond a modest period of years.

The next formal report on the BURBANK project,[113] designated as "Grant No. 310, Experiments in Plant Development," bears evidence of having been edited but some of BURBANK's personality remains. He undoubtedly had more to say about the earthquake than is printed as it was true that the small greenhouse was uninjured while the wooden residence only a few feet away was badly cracked and the chimney thrown down. The incident was much commented upon at the time. The fact that he suffered some property damage while his extensive experimental work came off scatheless appeared, to the sentimentally inclined, to be miraculous and further strengthened their belief in his being a superman. Here is the report, as published:

"Most strangely and most fortunately the great earthquake of April 18, 1906, which leveled the whole business section of this city [Santa Rosa] in a few seconds, did no damage whatever to the greenhouse or to any of the plants.

"The work of crossing and continual selection of promising variations continues as before, and an unusual number of new species and varieties of wild and locally known plants have been received and are being carefully inspected for characters of value either for economic or scientific purposes. Five hundred and twenty-two native species and varieties were received from native collectors in South America, 241 from Australia and New Zealand, and nearly 200 from various other parts of the world, among them many promising new types of Solanums, Opuntias, native wild fruits and vegetables, locally known and medicinal plants, trees, shrubs, and flowers, nearly all from seeds, thus obviating danger of insect pests and greatly lessening the expense and giving a better opportunity for selection by having greater numbers. . . . Great progress is being made with the Opuntias, plums, nuts, and berries, among all of which unequaled opportunities for the study of scientific laws and principles have developed."

Editorial comment by President WOODWARD follows:[114]

"Mr. BURBANK reports that the year just passed has proved very successful for the extensive experiments and investigations in plant, fruit, and flower development carried on by him thru aid granted by the Institution. By great good fortune the earthquake which proved so destructive to the city of Santa Rosa in which he lives and to the surrounding country, did very little damage to his property. In one respect, doubtless, the earthquake was advantageous to him and his work, namely, in preventing visitors from encroaching too freely on his time and attention.

"Thru the agency of a committee, consisting of the President, as chairman, and of Messrs. C. B. DAVENPORT (Director of Experi-

---

[113] *Ibid.*, Year Book No. 5, p. 125, 1906.
[114] *Ibid.*, Year Book No. 5, p. 24, 1906.

mental Evolution), D. T. MacDougal (Director of Botanical Research), and A. G. Mayer (Director of Marine Biology), heads of the departments of biological research, the task of preparing a scientific account of the ways, means, and methods employed by Mr. Burbank in his unrivaled work has been undertaken during the year. In May last all members of this committee except Dr. Mayer visited Santa Rosa and conferred with Mr. Burbank in order to develop a program for this undertaking. In accordance with this program, the details of which need not be stated here, Dr. George H. Shull, of the staff of the Department of Experimental Evolution, spent a portion of the summer in work at Santa Rosa, and he has recently returned thither to resume his labors. It is contemplated to have Dr. Shull spend parts of two or three years at work with Mr. Burbank, and to call to our aid also the services of other specialists of the departments of biological research.

"Although space forbids a further account of this work here, the President desires to record his warm esteem of the scientific spirit of cooperation shown in this enterprise by Mr. Burbank, by the members of the committee, by Dr. Shull, and by numerous colleagues whose counsel has been sought. By means of the cooperation thus secured it is confidently believed that the diverse scientific and economic ends in view may be achieved in ways which will commend themselves alike to the Institution and to the general public."

Burbank's next report,[115] for the year 1907, bears evidence of having been condensed and much edited but it still is Burbank's, not Shull's, who was now on the job as "collaborator." All of Burbank's unsupported statements and claims of having produced new species, and the number of separate species and total number of plants under observation, are still accepted at face value. The report is reproduced in full, as published:

"Within the limits of this annual report Mr. Burbank finds it possible to give only a brief account of his experiments and operations in plant improvement. This work, which has engaged his attention for the past 39 years, is of steadily growing interest, and its cumulative results are more evident than ever before. He has now under experimental test over 3,600 distinct species of plants, and many thousand varieties of some of these. Over a million seedling plants are raised each year for selection and for the study of variation from the effects of crossing. The newly developed fruit and fodder plants are attracting great interest—not only in the United States, but in many foreign countries. New species have been established which go on their way with the same unchanging precision of typical characters as do any of the species established in the past by nature.

"One of the interesting recent results is the production of a distinct new species of Solanum (*S. burbanki*) by crossing *S. guineense* var., a native of central West Africa, with *S. villosum*,

[115] *Ibid.*, Year Book No. 6, pp. 176-177, 1907.

of Chile. The experiments leading to this new species were begun in 1895. From the cross-bred seeds numerous plants were grown in the early part of the season of 1896, all practically alike. Another generation of numerous individuals was brought into fruit the latter part of 1896, this third generation embracing some 2,000 individuals, all as much alike as if raised from any wild, fixed species. In 1907 the fourth and fifth generations have been produced, and among 30,000 plants, which have flowered and ripened abundantly, no variation toward either parent, or in any other direction, has occurred, and this new hybrid may therefore be classed as a distinct new species. *Solanum guineense* is a strong, bushy perennial bearing large quantities of black fruits of most unpleasant qualities; *S. villosum* is a dwarf, procumbent annual, which produces abundant clusters of small, hard, green berries, but the fruit of the new species is delicious, resembling the low-bush blueberry of the Eastern States, *Vaccinium pennsylvanicum,* in color, flavor, consistency, and general appearance. The species is grown with ease and will probably prove to be of great commercial value.

"Extensive experiments of extreme interest and importance have been conducted with *Zea Mays,* the common corn. This annual grass is evidently a native of America, but has not within historic times been found wild, the grass-like plant teosinte of Central America being its nearest wild relative. Like all other grasses, the kernels of the progenitors of *Zea Mays* many years ago no doubt grew at the top of the stalk, like sugar-cane, wheat, barley, etc. By these experiments the plant has been carried back, through many forms, to the original simple grass. It has also been crossed with teosinte. Numerous photographs, showing the strange ancestral forms, have been obtained, and it is hoped that the experiments, which are of especial importance to biologists, may be extended through another year.

"The new giant Opuntias so far produced will endure only about the same degree of freezing as the fig or eucalyptus trees. An effort is being made to produce hardy varieties which, it is hoped, can be cultivated successfully in more northern climates.

"Dr. GEORGE H. SHULL has taken notes on Mr. BURBANK's experiments and has made much progress, but new results of past experiments are accruing very rapidly, and additional trained scientific observers could be usefully employed upon this work.

"Dr. W. A. CANNON, of the Desert Botanical Laboratory, has under microscopical examination several of Mr. BURBANK's hybrids, and other hybrids are being studied by Professor WEBBER of Cornell University."

President WOODWARD continued to be hopeful. Dr. SHULL was busy trying to cull useful information from BURBANK's old records and no doubt had in hand an account of his current activities but of necessity, at this stage, was not yet well enough informed to justify a protest against publishing all of BURBANK's statements and claims in his reports, essentially as written. He, however, must

have said something as the President was noticeably more cautious in his editorial comments in the 1907 report. It must have startled the President of the Institution to learn that BURBANK's experiments, which had been heralded to him in such laudatory terms, were often uncontrolled and his records meager.

Yes, there had been a grave misunderstanding. BURBANK thought he was being subsidized to enable him to gather together more plants so that he could make more wholesale crosses, and the President and Trustees of the Carnegie Institution assumed that BURBANK's numerous experiments had been conducted in the usual manner—with checks, controls, and elementary safeguards for insuring the purity of his hybrids so that their parentage would be known and, finally, that surely he had enough random notes to make it possible to chart the heredity of some of his complicated crosses.

The awakening, on both sides, was not pleasant. As the cold eye of science began to view the situation, the over-inflated balloon of possibilities began to shrivel. BURBANK's enthusiastic friends—with the best of intentions—had misrepresented the case. BURBANK's popular reputation was so great and his spokesman so insistent, that the Institution, apparently, had yielded to the pressure and voted a subsidy without making the usual careful examination into the merits of the request — or demand — for assistance.

SHULL found himself in a difficult position. In accepting the appointment as collaborator, he had, to a certain extent, staked his reputation as a scientist on the results of the BURBANK studies. A modern geneticist and a scientist of the purest type, SHULL could not be expected to have much sympathy with the primary aims of BURBANK. On the other hand, BURBANK had only an inkling of SHULL's ideals. Add to this BURBANK's independence and self-esteem and we have a perfect setup for a clash of wills. But both had much to lose by being stubborn—one a reputation, the other a large sum of much-needed money and the prospect of being received irrevocably into the ranks of science. And it is much to the credit of both that they did labor together for nearly five years. SHULL, especially, deserves a bouquet for BURBANK was known to be a difficult man to work with, particularly if it became necessary to oppose him or in any way to direct his activities; and SHULL had to do both of these things. What success he had was due to the exercise of tact, perseverance, and patience. Musing on this period more than 30 years later SHULL remarks:[116] "I learned from the start that my problem was chiefly a psychological one."

President WOODWARD commented briefly on BURBANK's report for 1907:[117] "The experiments and investigations of Mr. BURBANK and the work of preparing a scientific account of his methods and achievements are progressing as favorably as the available division of time and labor will permit. Being necessarily and properly very

[116] Letter to the author, November 25, 1939.

[117] *Ibid.*, Year Book No. 6, p. 27, 1907.

busy with his own affairs and overburdened by importunities of the public, the amount of time available for conference concerning the origin and the history of his productions is limited.

"Dr. SHULL, of the staff of the Department of Experimental Evolution, who is collecting the data for the account just referred to, has been at Santa Rosa for two series of conferences during the year, and plans to spend a portion of each year there until this work is completed. Dr. CANNON, of the Department of Botanical Research, has also spent a portion of the year at Santa Rosa, studying especially the physiology of some of the numerous hybrids developed by Mr. BURBANK.

"One of the most important results which may be expected to arise from Mr. BURBANK's work and from the interest in it taken by the Institution is a general stimulus to scientific horticulture. That contemporary society is ready to appreciate and utilize such a stimulus is a noteworthy sign of the times. Thus, many individual and governmental enterprises are giving attention to the economic advantages to be gained from rationally conducted experiments in this field, while biologists in increasing numbers are devoting their studies to the more recondite laws which govern plant, fruit, and flower developments."

BURBANK's report for the year 1908, which seems to have been his last one—at least the last one to be published in the Year Book, appears under the title, "Grant No. 483, Experiments in Plant Development,"[118] and looks to have been edited down to two paragraphs, though he must have written much more: "Experiments on Mr. BURBANK's plantation have been carried on with vigor and have been greatly increased in extent. The work on the cactus has interested numerous foreign governments and some of them are now growing the new cacti lately developed on Mr. BURBANK's grounds. These plants are grown without care, culture, or fertilizer, and on hard dry ground, without water, yet the average 3-year-old plant yields over 50 pounds of delicious fruit. The work is well advanced toward making a more hardy species and thus extending the culture to colder quarters of the globe. Mr. BURBANK also hopes to bring about a still further productiveness in the cacti, as well as a better chemical composition for the plant, and fruit of various colors, flavors, sizes, and seasons.

"A new series of thornless blackberries, with unique qualities, has been developed and many improvements have been made in plums, prunes, peaches, nectarines, apricots, quinces, plumcots, cherries, raspberries, and numerous other fruits. New forage plants, new roses, bulbous plants, ornamental, nut, and forest trees, and field crops have been grown, and several collectors are employed in securing seeds of wild plants from remote sections of the earth."

The President now seemed to realize that he had been grasping at intangibles—that the BURBANK project was becoming vexa-

[118] *Ibid.*, Year Book No. 7, p. 183, 1908.

tious, and from the viewpoint of the Institution less fertile of results than had been anticipated; in short, that he had been imposed upon by the BURBANK boosters. SHULL had been disillusioned for some time, I believe, but stuck doggedly to his task of trying to keep on amicable terms with BURBANK — who was highly nervous, on account of what to him was unwarranted interference with his manner of life—and still salvage what he could from his impossible task.

From 1908 to 1909 onward, embarrassments began to pile up. The Institution was still under fire by entrenched scientists who wanted the benefaction terminated; unrestricted speculation in "spineless cactus" was becoming a scandal; the controversy over the Wonderberry—a BURBANK production—was raging in the press, and the captious were saying to the Carnegie people, "We told you so."

I have no direct information regarding President WOODWARD's reactions to the outcome of the project but it is only reasonable to suppose that he was both embarrassed and humiliated at the debacle. How to ease out of the commitment and preserve the dignity and prestige of the Institution he represented was the problem. He could not very well tell the world that he and his Board of Trustees had been imposed upon, for some of the trustees who presumably were most active in making the commitment were still on the Board and might still be unconvinced that BURBANK was not worthy of their support.

While it had been rumored that it was the California members of the Board who had been instrumental in having BURBANK approved for a benefaction, this view cannot be literally true, as none of the members at the time claimed that state as their residence but, as pointed out earlier, three of them had lived there previous to 1905 and conceivably might have had a partisan interest in doing something for the state. Also, which is more probable, they may have been the instruments through which California admirers of BURBANK worked to have him recognized.

Dr. GILMAN died in 1908 and D. O. MILLS in 1909, but Judge MORROW, the former Santa Rosan, was an active member of the Board until his death in 1927. If former Californians exerted the influence they are credited with, it is highly probable that only two men were involved—MILLS and MORROW, neither of them men of science and therefore most likely to have had their interest aroused through sentiment, state pride, and popular clamor.

Here are President WOODWARD's observations on BURBANK's report for 1908.[119] They are brief and must have been inscribed in the bitterness of disillusion:

"As explained in previous reports, Dr. G. H. SHULL of the departmental staff, has in preparation a scientific account of the horticultural methods and products of LUTHER BURBANK. In conformity with the plan adopted by the committee (consisting of the

[119] *Ibid.*, Year Book No. 7, p. 27, 1908.

heads of departments of biological research and the President) having charge of this work, Dr. SHULL was sent abroad in August of this year for the purpose of visiting the principal horticultural establishments of Europe. By aid of this opportunity it is hoped that Dr. SHULL may not only become better qualified to place the aspects of Mr. BURBANK's work in their proper relations, but that he may also gain knowledge of value in the conduct of his own experiments in plant-breeding carried on at Cold Spring Harbor."

The benefaction was not discontinued at once, as the records of the Institution show that BURBANK was paid $10,000 each year from 1905 to 1909, inclusive, a total of $50,000.

The remaining references to BURBANK are very brief. Under "Departmental Reports for the year ending October 31, 1908, Department of Experimental Evolution, Breeding Strains of Plants", it is noted that "Dr. GEORGE H. SHULL, although occupied during much of the year (from February 15 to May 30) with his study of Mr. BURBANK's horticultural methods and results, has been able to continue most of the strains listed in last year's report. . . . On August 14 he started on a tour of the principal plant-breeding establishments of Europe." And again at the end of the year 1913, President WOODWARD explained, "the exigencies of his experimental work going forward at the departmental station have prevented Dr. SHULL from completing the manuscript of his account of the work of LUTHER BURBANK. It has been arranged, therefore, that he shall spend some months abroad, beginning with October, 1913, in order that uninterrupted attention to this manuscript may enable him to finish it without undue delay."

The next year, 1914, in his annual report, the President disposes of the BURBANK episode in a single sentence, sandwiched in among comments on other activities, by observing that "Dr. SHULL, of the departmental staff, spent the year in Berlin preparing his account of the horticultural work of LUTHER BURBANK." Just that and nothing more. The report never has been published. As a matter of fact, Dr. SHULL tells me that it is not yet finished. He says the Institution was under no obligation to publish a report which, undoubtedly, was true but, nevertheless, it was only a reasonable assumption for the public to expect one, as that would have been following normal procedure. What the public did not know, apparently, was that from the beginning there had been an understanding between SHULL and the Institution that nothing would be published during BURBANK's lifetime. This, no doubt, was considered to be a necessary precaution because intimate acquaintance with BURBANK might render it difficult, if not impossible, to discuss his work with that degree of candor demanded in a scientific report. Unfortunately, the motive involved — sparing BURBANK's feelings — could not be given publicity, thus creating an air of mystery and misunderstanding.

Failure to give an account of SHULL's five years' study opened the door to rumors and speculation. One group of partisans declared, in view of the attacks that had been made on BURBANK

by representatives of science, that the Institution dared not publish the facts lest he be vindicated, while the opposite camp wishfully concluded nothing had been found that was worth publishing — that BURBANK was a dud, a false alarm.

Without any explanation of the findings from a project on which the Institution had expended from fifty to seventy-five thousand dollars, it was assumed by a neutral public that results had not come up to expectations. Possibly the public never understood precisely what SHULL was instructed to do. He has told me lately that "the Carnegie Institution accomplished what it set out to do and was neither surprised nor disappointed in the results. . . . It was a fact-finding commission and I believe was successful in finding most of those facts which were relevant to an evaluation of the work for science."

My own conclusion is that President WOODWARD faced a perplexing situation, was not certain what course to pursue. There were some good things that were worth reporting (and may yet be reported), but they were not of world-shaking importance and, in view of the vicious attacks that had been made on him by BURBANK followers, he was in no mood to throw even a crumb of acknowledgement their way. And there also were the BURBANK critics, who hoped to see him authoritatively denounced. This WOODWARD could not do. It would be undignified — an admission of laxity in judgment — and besides, he harbored no such feelings toward BURBANK. His dignity permitting, he no doubt could have, with relish, issued a broadside against the BURBANK boosters. Conditions being what they were, he did nothing for either faction.

SHULL was in a predicament. He could not make a favorable report such as BURBANK and his followers expected, and his regard for BURBANK would not permit him to say derogatory things about the man and his work. He was in a position to recognize BURBANK's sterling virtues — together with his faults, which were more ridiculous than vital. These were personal matters which are reminiscent of the attitude of Santa Rosans who loved BURBANK despite his imperfections. But SHULL was under the responsibility of sitting in judgment on BURBANK's contributions to science. He has said that some things were good, and worthy of publication, but presumably there were not enough of these to offset those things that were not so good. Anything published would have to be good indeed to withstand hypercritical reviews that were sure to be made by institutional scientists. With no publication there would be nothing specific to defend. With the passage of time the need of publication seemed to diminish, and by the time BURBANK had completed his life work SHULL had become absorbed in his own genetical researches which, to him, seemed more important than working over his old BURBANK records, to recover a few flakes of gold from a large mass of sand. This brings the story down to date.

There was plenty of criticism from BURBANK's followers when the subsidy was abruptly terminated, apparently without advance

notice of any kind. BURBANK's pride was hurt. It was a blow to his prestige, and doubtless he was seriously discommoded at the sudden and unexpected loss of such an important part of his income. There was a curt interchange of letters between him and President WOODWARD. As usual his friends took up the battle and barraged the Institution with indignant and acrimonious protest. One magazine summed up the controversy in a highly sarcastic article entitled "The Application of Knowledge,"[120] presumably written by EDWARD F. BIGELOW, Managing Editor:

"Twelve million dollars could not have been invested to put into practice a grander idea than that expressed in the articles of incorporation of the Carnegie Institution of Washington — 'That the objects of the corporation shall be to encourage in the broadest and most liberal manner, investigation, research, and discovery, and the application of knowledge to the improvement of mankind.'

"But the value depends upon the way in which this expression is construed. Does the final clause, 'the application of knowledge', follow as the climax of all that has gone before — the end devoutly to be desired: or is it to be regarded as the least important part of the statement? The last-mentioned construction of the relative importance of the things to be 'encouraged' appears to be the one adopted, or possibly is the one that has always been maintained. This seems to be the case, since the Institution has summarily, and apparently, if not intentionally, insulted LUTHER BURBANK by discontinuing the allowance formerly given to him. President WOODWARD is strenuous in declaring that the allowance was not pledged for ten years, nor for any other special time, as Mr. BURBANK so understood it, being justified in thus believing, because one of the Trustees told him so. A Trustee is supposed to be well informed, and to speak with authority.

"It looks as if the Carnegie Institution thought it was buying a giltedged deluxe edition of 'BURBANK'; that it read and re-read him and copied him for a few years, gladly PAYING for these great privileges the paltry sum of ten thousand dollars a year. In the first years of this allowance, when Mr. BURBANK was so extensively exploited by the newspapers, when it was impossible for him to personally meet more than a small percentage of the visitors who made pilgrimages from all the world to Santa Rosa, he could easily have made twice ten thousand dollars if he had 'gone on the road' as a lecturer, and had devoted to lecturing one-half the time that he gave to the supplying of the Carnegie Institution with information. It was seemingly not in any sense an encouragement, but a shrewd bargain to use the man to the extent of its desires, in exchange for money, an exchange of which he was not aware. In other words, he, like any other interesting book, was to be read so long as he pleased the high and mighty Institution, and was then to be tossed aside with no thought of the effect on the book. So they read on, and by and by they found several blotted pages

[120] The guide to nature. September 1910.

devilishly inserted by jealousy, and they threw the book away. . . . The action brought glee to less efficient horticulturists. They rubbed their hands and patted one another on the back and said, 'We did it by our letters and resolutions.'

"From extensive correspondence with Mr. BURBANK and President WOODWARD, I quote this tender appeal and the iron hearted reply.

"From LUTHER BURBANK (letter of June the 28th): 'I would ask you plainly why do the Carnegie People refuse to give the full facts, I DEMAND them . . . I have never desired any publicity, and would always have greatly preferred private life except that it was necessary to mention my new creations in order to sell them to keep the work going; but I now desire publicity and lots of it, the more the better. I wish this thing dug to the very earth and the guilty parties exhibited to the light.'

"From President WOODWARD of the Carnegie Institution (extended letter of August the 4th, following several others): 'I have already declined to state the reasons for the action of our Board of Trustees in reference to Mr. BURBANK. Out of consideration for him especially (Oh, mark well the kind 'consideration') the history of our attempt to cooperate with him in his work should not be given to the public until after his deth' (amended Carnegie spelling and not a typographical error.)

"And then in the same letter gratuitously to the writer: 'You show plainly that having acquainted yourself with only one side of a question you are nevertheless certain that there is no other.' (This following repeated inquiries for information) 'If your mind is already made up I shall not be disposed to pursue the subject further. . . .'

"And again in the same letter: 'Similarly your sense of humor and mental arithmetic ought to show you that if we distributed our income pro rate among applicants for it they would receive less than ten dollars apiece. What would you do under such circumstances if you were a Trustee and if you knew you would be held responsible for your acts? What would you do if you had to listen to a hundred times as much advice as you could possibly use on every project the minds of men can conceive? How would you get on with your own affairs if you had ten times as many applicants for aid, positions, and shares in your income as it could stand? Would not your sense of humor come to your rescue? . . .'

"Now that you have requested my advice, I gladly give it. Go on with what you started to do, at least so far as not to bring sorrow, insult and injustice to Mr. BURBANK."

Scarcely an antifebrile statement, and I hesitate to use it even after omitting more than half of the original, along with the more intemperate invectives. I do so because time — the efficient healer — has now so far allayed the fever of controversy, with little likelihood of its ever becoming epidemic again, that it becomes possible to round out the picture of a truly remarkable man and show what a tremendous hold he had upon the imagination and confidence of

his followers. The Biblical parallel was very close. The Messiah had come, had fulfilled an earthly mission, was being crucified by unbelievers — His followers gladly took up the cross and carried on. The jeremiad quoted was not exceptional; it was typical of protests that continued to appear in the press as long as BURBANK lived, directed not at the Carnegie Institution alone, but against what was thought to be the persecutions of the scientific world in general.

BURBANK's valedictory to his foray into science appeared in one of his catalogs:[121] "Yes, after having been under 'capture' for the avowed purpose of 'the benefit of science' for five years by the Carnegie Institute of Washington, five years of care, leanness, hampering restrictions and unprofitable conditions, and having dictated to and corrected for their botanist several thousand pages, it is a most gracious relief to return to a life free from the red tape of institutional restrictions, with its accompaniment of envy and jealousy, to a life of active freedom. . . ." BURBANK, no less than the Carnegie Institution, was truly a victim of the unrestricted — almost fanatical — activities of his admirers.

[121] A new prune—the Standard. A new early cherry—the Burbank. A good little hardy plum—the Glow. A new strawberry—the Patagonia. p. 26, January, 1911.

XVI

BURBANK'S ADMIRERS

A PERUSAL of BURBANK's monumental scrapbook, kept over a period of 50 years and consisting of approximately 5,000 pages, gives a vivid picture of his personal and professional popularity. This word picture is a running record of what his admirers had to say about him in print. The items were taken from newspapers, agricultural and horticultural journals, magazines and advertising literature. Not all of it was laudatory but ninety-five per cent of it was. Apparently he did not always subscribe to a clipping service, for there were periods when the comments were too uniformly favorable to be truly representative of public opinion. At other times there were scattering brickbats among the bouquets. It must have required courage to preserve some of the more vitriolic comments. Scores, if not hundreds of longer articles, both favorable and unfavorable, must have been omitted to save space, as I have seen them elsewhere.

Clippings from home-town and neighboring newspapers, in the aggregate, account for many pages in the books. These tell of the arrival of visitors and the local doings of BURBANK and his business affairs. There seems to have been a friendly conspiracy to relate nothing that was disagreeable, or that in any way, even remotely, reflected on the man they loved. And the same is true today as regards his memory.

During the hectic days of 1912 to 1915, inclusive, the newspapers told of the grandiose plans of the Luther Burbank Company and the Luther Burbank Press but had little to say about how they turned out. Local papers accepted full-page advertisements of bond-selling schemes but editorially and in the news columns there was not a single comment. And when the schemes came to grief there was little said beyond what was a matter of court record. I have not found even a bare announcement of his divorce in 1896 in any of the papers, a most remarkable tribute of loyalty to a popular idol. Even more significant is the fact that all this was not brought about by plan or design, but by common consent. Editors did not need to be told; their duty was obvious and they did it.

While BURBANK's admirers were legion, most of them never saw him, for he traveled little. For more than 30 years he was a famous man — a notable — and during that time thousands visited his gardens in Santa Rosa. Admiration was not the primary urge that prompted them to go, but curiosity. However, all, or practically all, went away as admirers.

The popular press was the chief force — the mighty agency — that won both fame and admiration for BURBANK. A man may be famous but not admired. BURBANK was both, in full measure, if we reckon by numbers. Space writers whose business it was to please the reader wrote reams about BURBANK, sometimes from personal knowledge and sometimes at second hand. Editors, whose duty it was to comment on people and things in a big way,— impersonally, of course — rhapsodized about him.

So strong was the current in this direction that anyone with a contrary opinion had great difficulty in obtaining a hearing. I have before me a manuscript of book length, entitled "The Life and Work of LUTHER BURBANK", written by a geneticist — a man well qualified to discuss plant breeders and plant breeding — but publishers declined to bring it out on the ground that it was critical of BURBANK. So it was and so it was intended to be. The author tried to be fair and honest in his criticisms as he would in reviewing the work of a colleague, but he made the mistake — unconsciously, no doubt — of instilling into his otherwise impeccable statements slight traces of institutional venom. One publisher, with a fine eye to business, offered to hold the manuscript and use it *after* BURBANK's death. The author naturally refused this proposal as it would have defeated his purpose in writing the paper, which was to dethrone a popular idol.

At that, the manuscript was not as critical as was an article published in a trade paper about this time, which was of the debunking type, but the public heard little of it as the periodical circulated chiefly among florists and gardeners. This clientele was much impressed and pleased at the exposé as many of them were in the business of selling seeds and plants — also in improving them by breeding — and therefore were professional rivals of BURBANK.

BURBANK's admirers employed two successful means of approach in building up and maintaining the prestige of the man: by playing up his lovable character and by depicting him as a wonder-worker with plants. Emphasis, of course, was on the latter attribute; and, according to the viewpoint, temperament or personal bias of the writer, he was variously credited on the one hand with being a scientist of high order and on the other with being in league with the supernatural. Of course they could not say, in so many words, that he possessed supernatural powers, but, whether intentional or not, that certainly was the impression left in the minds of many of their readers.

Admirers of BURBANK rarely conceded the possibility that some of his productions might not prove to be a success. That they would be a success, that is, useful, was taken for granted and the natural corollary was that he was, therefore, a benefactor of mankind. And the stories were made intriguing by enveloping his performances in an aura of mystery. To the popular reader this made the greatest appeal of all. BURBANK himself did not relate any such stories; they were invented by his enthusiastic admirers. However, by constantly stressing the long hours of unremitting

labor which he devoted to his plants in effecting their improvement — for the most part absolutely true statements — they cleared the way, as it were, and prepared the minds of the credulous for accepting the fantastic tales that appeared in the press, often in the guise of popular science. Owing to the almost universal lack of information about the prosaic facts of plant propagation (budding and grafting in particular), as well as of pollination and seed formation, even otherwise well-informed persons are apt to display a child-like curiosity and admiration toward the person who propagates plants and cross-pollinates flowers, and attribute to them powers they are not entitled to. The processes seem mysterious, so they are willing to believe mystery stories about them. Skillful writers, with little or no technical knowledge of plant improvement, saw their opportunity and availed themselves of it by writing catchy stories of the wonders performed by BURBANK. Some wrote BURBANK panegyrics for the love of it or because they were enthusiastic admirers of the man, but the worst offenders were those who did it for pay and with a cynical disregard of facts.

I say little about one class of BURBANK admirers — those who sold his productions. After paying a few hundred or a few thousand dollars for a new flower or fruit with full power to multiply it and sell it at retail, it would have been a strange merchant indeed who did not eulogize BURBANK and cry his wares from the housetops. Some no doubt purchased for the advertising value of the BURBANK name regardless of whether they admired the man or whether they thought the product was intrinsically valuable, but mostly the purchasers were followers of BURBANK and believed in the things he produced. However, being a customer was sufficient incentive for glorifying the man and his accomplishments and to this class of boosters he was indebted for much of his favorable publicity.

The clergy made valuable contribution to his fame by way of the sentimental route. And there was not an iota of deception here, for they believed everything they said. In depicting his idyllic life among his flowers, his stainless character and his love of children, they were on safe ground but when, in their enthusiasm, they attributed his succcess to Divine guidance, a distinctly wrong impression was created. The credulous who believed such stories were certainly left in a state of mind to be imposed upon by those who exploited BURBANK for personal gain. And why not believe them when the persons making the statements were men of undoubted integrity?

Many years ago I was traveling in the back country of the Missouri Ozarks. At a village 30 miles from a railroad, where I stopped for the night, excitement was in the air caused by the reported discovery of a fabulously rich copper deposit in Arizona. A promoter had sold stock right and left by the clever device of telling people on his first visit that he did not ask them to accept his word but that he would pay all the expenses of anyone they might select to go to Arizona and see for himself what he had to

offer. The man the community had the most faith in was the minister of a local church who made the trip and reported that with his own eyes he had seen a whole mountain of copper which only awaited development. This turned the trick and the promoter made a cleanup and moved on. And this had just happened when I arrived. The populace was in a happy state of mind with rosy anticipations and could talk of nothing else but its good fortune. I was a doubter in the midst of universal optimism and got in bad — very bad — by asking what their good minister knew about minerals, and copper ores in particular. I was so unpopular that I had to hasten my departure. Yes, you have guessed the outcome. The minister was duped and the whole thing was an unscrupulous fraud.

Honesty and good intentions are excellent qualities in a man but they do not make him a horticultural or mineralogical authority. However, where men of known honesty and established character — as the clergy — spoke highly of BURBANK and praised his accomplishments, they enhanced his reputation. In the end, though, the clergy as a class repudiated him because they did not like certain theological views he was alleged to have expressed but his fame was so great that it safely withstood this stress.

The public understood that the ministry had endorsed BURBANK as a sort of miracle man as a plant breeder, and this opinion coming from such a highly respected source was widely accepted. When the clergy later denounced him for his religious views — but not as a wonder-worker — his admirers refused to drop him. True, many religious people were saddened but their devotion to their idol continued undiminished. A common defense was, "I don't believe he said the dreadful things attributed to him, but even if he did, his religious views are his own private affair and we have no right to criticise them." [122]

Perhaps the most consistently faithful admirers of BURBANK are to be found in our public schools. To be sure they did not help much, if any, toward establishing his reputation in the first place but they certainly seized upon it when it was established and carried it forward by classing the new favorite along with WASHINGTON and LINCOLN. Ten and twelve-year-old children throughout the land are taught that WASHINGTON delivered us from our oppressors and moulded the jealous colonies into a powerful nation with a constitution that guarantees all the things that a democracy holds dear; that LINCOLN was the Messiah that arose in the dark hours of our need to rescue the Union from disruption; and that BURBANK by his creative genius gave the world both beauty and sustenance — things of loveliness to please the eye and exalt the soul, and things of worth to feed the mouth and fill the purse. In short he is represented as one of the greatest peace-time heroes our country has produced.

---

[122] The gist of scores of letters to the author from religious persons in all walks of life, including the ministry.

All of which stirs the imagination of the child and he never forgets the BURBANK character that has been pictured to him; and certainly no harm has been done unless the teacher becomes too enthusiastic and overdraws the picture by representing the character either as a great fundamental scientist or as being in league with the supernatural. In both directions lies trouble for the pupil when he grows up and repeats these views only to be ridiculed. If he becomes a student of science in later years some of his youthful ideals will be shattered when he discovers certain facts for himself. It cannot be repeated too often that BURBANK really did perform a notable service to science, and history will not permit his name to be forgotten, but his admirers must not claim too much for him.

BURBANK's fame will be perpetuated through the schools because his life is a most attractive subject for children to study. And, if his accomplishments are fairly presented, and no liberties taken with the facts, his legitimate fame will remain unsullied. If romanticism and mysticism predominate in the presentations there may be a reaction that will tend to discredit the man entirely which would be very unfortunate.

XVII

BURBANK'S DETRACTORS

THOSE who spoke disparagingly of BURBANK's work fall into four general categories: Persons connected with scientific institutions — state, federal, and private; jealous business rivals and competitors; dissatisfied purchasers of his products; and crusading debunkers. Truth is the guiding star of all scientists worthy of the name and as a class they are prone to be severe — even ruthless — in their criticism of persons who make statements not properly supported by acceptable evidence. Some may go further and question a man's fitness for laying claim to scientific achievement by scrutinizing his formal education — what degrees he holds and whether he was trained in this or that laboratory, of this or that institution — and if he does not measure well by conventional standards, his claims may be dismissed as being unworthy of serious consideration. This would be particularly true of those scientists who labor for the inner glory of making contributions to the advancement of abstract knowledge. These would condemn BURBANK unequivocally, if they took the trouble to think of him at all.

Scientists in technical institutions like the agricultural colleges, state experiment stations, and the United States Department of Agriculture, while faithful to the ideals of their cult, are nevertheless realists, and therefore less disposed to look with jaundiced eyes upon the offerings of anyone, be he layman or to the manner born, if his contribution can be shown to be useful to society. But agricultural scientists have another duty aside from teaching and research — they are expected to give technical advice on everything from animals to zinnias, and to serve as watchdogs for the protection of the public from frauds that may be perpetrated under the guise of agricultural betterment. And they take this last obligation seriously. Thousands upon thousands of inquiries, in the aggregate, are answered annually. Many of these are concerned with the value and trustworthiness of new varieties of plants offered for sale. It is the duty of the public agencies mentioned to keep posted on such matters.

When some unusual crop plant comes on the market there is certain to be a flood of inquiries about it. This was what happened when the so-called thornless cactus was first widely advertised. As a matter of safe policy, institutional workers are cautious about recommending the planting of new things, particularly for income purposes, even when promising, and the customary advice is to wait until the novelty or new thing has been subjected to experimental test. This was especially true in the case of the cactus, for it was

not only a new crop but an unusual one and, moreover, extraordinary claims were made regarding its value.

BURBANK made some pretty tall claims himself but promoters went much farther. BURBANK declared they were discrediting him by saying that this semi-tropical plant could be grown far north whereas he insisted that it could withstand only a few degrees of freezing. The United States Department of Agriculture officials took the more fundamental stand that forage cactus of any kind — spiny or spineless — was at best only an emergency crop to be used in years of extreme drought when both range grass and water were scarce. They readily conceded that cactus could be grown in regions of low rainfall — that it is adapted to the so-called deserts of the Southwest — but made it clear that growth would be slow and that no such yields as claimed for it could be expected without cultivation and irrigation.

The inference to be drawn was that under these circumstances some forage crop with higher nutritive value should be grown instead of cactus. It was further pointed out that, while the spiny Opuntias have as high feeding value as the spineless forms, it is necessary to go to the trouble and expense of ridding the slabs of their spines by singeing them off with a blow torch. On the other hand experience had shown that cactus without spines had to be fenced to protect it from rabbits as well as cattle and sheep — to prevent them from exterminating it — thus making it a farm rather than a range crop.

Substantially the same conclusions were reached by Professor J. J. THORNBER, Director of the Arizona Agricultural Experiment Station, after experiments in growing and feeding both spiny and spineless cactus. The fanciful stories written about the possibilities of spineless cactus authored by irresponsible space-writers and others along about 1903 to 1912 caused an avalanche of inquiries to be sent to the United States Department of Agriculture in Washington and to many of the State experiment stations, and in accordance with their policy of conservatism, the replies were uniformly unfavorable. BURBANK's friends and admirers quickly leaped to his defense although in many instances they were defending the statements of dealers in cactus and the emanations of careless writers rather than what BURBANK claimed. This brought sharp retorts from the institutional guardians of the public. Because BURBANK had made extravagant claims in the first place and continued to repeat them, and because everything that others said in praise of the crop was understood by the undiscriminating public as also coming from BURBANK, the discussions narrowed to a controversy between BURBANK and the cactus specialist in the Department of Agriculture, Dr. DAVID GRIFFITHS, with much bitterness on both sides.

On the whole, institutional critics were not motivated by personal animus when they encouraged people to resist the sales talks of those who had BURBANK products to sell; it was all in the day's work in the performance of their duty as protectors of the

body politic. However, the persistence with which dealers — presumably with BURBANK's blessing — continued to push the sale of cactus in the face of governmental opposition convinced many officials that BURBANK had violated the primary principle of a scientist in that he was not amenable to the truth. And this view has been handed down to the present generation and has given him the reputation of being a tricky salesman. Also it was intimated, and even directly charged, that there was no such thing as a completely spineless cactus and that the forms he was selling were "spineless" by nature and that he had received them from his collectors in some other country and proceeded to propagate and sell them as his own creations. Some good men have believed this but I have the evidence of Dr. SHULL, Professor DE VRIES, and of two or three persons who worked for BURBANK — as well as several photographs of seedling collections of cactus taken from 1901 to 1905 — which I think sustains his claim that he did produce certain forms of "spineless" cactus by a process of hybridizing, selecting and hybridizing again and again over a period of eight to twelve years. BURBANK did not claim to have produced an *absolutely* spineless form but had succeeded in reducing the spines to a point where the plants could be used as a roughage by animals without danger. He also admitted that forms as near spineless as his were to be found in nature — in fact he had received such specimens from the collections of Dr. GRIFFITHS in Washington, D. C., and Chico, California. My studies convince me that he has been charged with some things that he is not guilty of.

Granting that he was a shrewd salesman and that he refused to admit that cactus was not a valuable forage plant, I cannot see —

TEXTFIGURE 5.—COVER OF A 1912 LEAFLET.—Nearly twenty years after BURBANK's death, he is still criticised because he advocated the planting of cactus for fruit and forage, and for claiming to have originated varieties devoid of spines. Here are the facts: From Mexico, the Mediterranean countries, and other places he brought together a large collection of cactus types of the genus *Opuntia*, chiefly *O. Ficus-indica* and *O. Tuna*. Some were exceedingly spiny, others almost spineless. A large-scale breeding program was started in the belief that fruiting types could be much improved, and other types made suitable for forage by getting rid of the spines.

BURBANK never claimed that his was the only "spineless" cactus in existence but did claim, with justification, that by breeding he himself had produced varieties "as smooth as a watermelon." He admitted that DAVID FAIRCHILD of the United States Department of Agriculture sent him a specimen collected by one of their explorers, that for all practical purposes was spineless and that others might be found in nature.

BURBANK believed in the value of cactus, particularly for forage, and made enthusiastic claims for it, but it was the doings of others who purchased it for resale, that brought the industry into disrepute. Salesmen and irresponsible writers made ridiculous statements that went the rounds and the public attributed them to BURBANK.

Stockmen are on record as having testified that cactus was a valuable emergency feed for range cattle, but impractical to grow for that purpose, as it had to be fenced lest the animals eat it into the ground. Dairymen made affidavits, too, that it was a good supplemental feed for milk cows, but again it must have been unworthy in some way, as it was little used.

The Gold Medal Newest

Agricultural-Horticultural Opuntias

SPINELESS CACTUS

"How to Judge Novelties, Look to Their Source," and, also, if Possible, Purchase Direct from the Originator

MANY new trees, plants and seeds are grossly misrepresented by a few dealers who trade on the reputation of reliable firms, often doing a thriving business by selling trees and plants in localities where they very well know that they cannot thrive; this and the substitution of inferior or wholly worthless trees or plants under the name and reputation of good ones has been, and is now being carried on persistently and systematically by several parties who victimize those who deal with them by trading on the reputations of reliable firms and good trees.

An especially cruel form of this is the persistent pushing of the Spineless Cactus, Crimson Winter Rhubarb and other tender plants for cold climates which cannot live where the ground freezes an inch in depth.

It should be the duty and privilege of every good citizen to aid in exposing and routing all who are obtaining money under these false pretenses.

Having been in business almost forty years, millions of trees and plants raised in my establishment are now bearing fruit, not only in the Western United States, but everywhere on earth where the sun shines and trees can be grown. Does this forty years record of just dealing mean anything, and is it surprising that such a reputation should be worth trading on? **Counterfeit coins are not counterfeited—it is the genuine ones that are misrepresented.**

Luther Burbank

SANTA ROSA, SONOMA CO., CAL., U. S. A.

May 1, 1912.

since he believed in it (at least in the earlier years when the original controversy was raging) — that all of this had anything to do with his being a scientist. It was no evidence, either for or against him. I have in mind, at the moment, an institutional man with an international reputation as a keen and productive scientist who is so avid for money that he recently patented a hormone that had been discovered in his laboratory and tried to bludgeon manufacturers into purchasing it, when he knew another patent was pending on a type of hormone superior to his; and when he failed to make the sale tried, by shady methods, to discredit the work of the rival group of research workers. When this becomes known, as it will, it may injure his reputation as a man but it will still have to be admitted that he is an able scientist.

The moral, of course, is that one must be a good scientist — must have conformed to the traditions and been accepted by his contemporaries—before he can afford to risk tarnishing his reputation by commercializing his talents. But institutional scientists, as a rule, do not have to worry unduly about where the money is coming from to support their laboratories and pay their salaries. BURBANK had to make his discoveries pay all the expenses of his home, gardens and greenhouse and if there was anything left he might call it a salary.

Another echo of the spineless cactus episode was the withdrawal in 1909 of a subsidy which the Carnegie Institution of Washington had made to BURBANK five years previously. The cactus controversy had exhibited BURBANK before the scientific world in the worst possible light and thus became a culminating incident in deciding the Institution to discontinue supporting his work.

At about this time a crusading debunker played an important role in an effort to discredit BURBANK. H. W. COLLINGWOOD, Editor of the *Rural New Yorker*, an influential agricultural journal, conceived the idea of what is now known as "honesty in advertising." A berry plant called the Wonderberry, originally sent out by BURBANK under the name of Sunberry, was being extensively advertised by JOHN LEWIS CHILDS, who had purchased the rights to its distribution. Mr. COLLINGWOOD undertook to prove that the Wonderberry was not only worthless as a fruit but probably poisonous as well. As usual, BURBANK was held by the public to be responsible for all the exaggerated statements made by the CHILDS Company. He did praise the novelty when it was first produced, which caused Mr. COLLINGWOOD to take him to task and to speak disparagingly of his work in general.

In 1909 BURBANK's reputation among institutional scientists was at a low ebb. What editors of rural publications, other than the *Rural New Yorker*, thought of him is not clear. Few had the courage to speak out as COLLINGWOOD did. With the rank and file BURBANK was still extremely popular despite the cactus and Wonderberry incidents. Apparently the average citizen thought these were not the only times the "city slickers" had attempted to

sell things of little value to the public. In the cases of both the cactus and Wonderberry many, if dissatisfied, undoubtedly placed the blame where it chiefly belonged — on the distributor.

Here and there jealous competitors of BURBANK carried on an under-cover warfare of calumny against him but these efforts at undermining his character and business integrity met with little success. I personally knew one nurseryman — a man himself of the highest integrity — whose outlook was so warped by jealousy or envy that he could not give BURBANK credit for a single worthwhile accomplishment. Incidentally, this man was also a breeder of certain fruits and was much chagrined that his hybrids which he thought were improvements over existing varieties of their kind received but little attention. He could not see why so much honor was accorded BURBANK and so little to himself. On the whole there must have been hundreds of others, especially in the floral trade, who were similarly situated, who sniped at BURBANK. Their plaints are to be found in many of the trade papers of the day.

Altogether, over the years, disappointed purchasers of BURBANK products account for a sizeable volume of criticism of the man. The largest part of this adverse criticism was engendered during the three or four years the so-called Luther Burbank Company of San Francisco was in business. Numerous cases have come to my attention where persons thought they had been dealing directly with BURBANK when as a matter of fact he knew nothing about the transactions. On the other hand BURBANK himself undoubtedly incurred a certain amount of hostility by reason of dissatisfied customers to whom he had sold flowers or fruits. Novelties have a way of not making good. Happily for him, most purchasers of new and highly touted things buy with their fingers crossed, so to speak, and do not expect too much.

The detractors of BURBANK were many and diverse but the volume of approval from his friends and admirers had a way of drowning out the voices of those who disapproved. Faulty or perfect, guilty or innocent, the *hoi polloi* loved him during his lifetime and cherished his memory after he was gone.

his own researches. Having known the history of genetics for forty years, even been a part of it, I value his judgment when he looks down the vista of four decades and says that BURBANK, by his labors, vitalized and hastened the growth of a line of endeavor that might otherwise have lagged on account of a lack of popular interest.

To the popular mind BURBANK was a fetish — an object of unreasoning devotion. In the last analysis his fame was based on intangibles. I have asked hundreds of persons why they thought he was a great man. Comparatively few could give any definite reasons although their convictions were strong. Upon analysis, fame is seen to be a bewildering attribute — sometimes funny or even ridiculous. It may have close kinship with notoriety and an unthinking public may mistake the one for the other.

If fame comes as a result of "common talk" or "opinion generally diffused" as the dictionary says, then history will accord LUTHER BURBANK a place in our list of notables. Few men of his time, in private life at least, were more sought after or more talked about. To the public he was a romantic figure and his admirers referred to him in the most extravagant terms. His name was known to the reading public in foreign lands and at the height of his career even to the illiterate. But by the same criterion JESSE JAMES the bandit might also have qualified for a place in the hall of fame. Make no mistake about this, bizarre as it may sound, for I lived in the Middle West and was a good-sized youngster when JESSE was bumped off, murdered, they said, by a "paid assassin" or "stool pigeon." There was a great upsurge of emotion at the manner of his riddance, forgetting that all other methods had failed, and even quite nice people were wont to say that JESSE never molested the common people, that he robbed only the plutocratic railroads and banks, and "sich." The newspapers of the time condemned the peace officers, played up JESSE as an American variety of Robin Hood — not always in these words, to be sure, but carefully and deliberately leaving that impression. They made of him a popular hero, for the public must have a shrine at which to worship.

I am not trying to, and have no thought of, comparing BURBANK with JAMES. Far from it. I am merely trying to show what a funny thing fame is. Another funny thing about fame — or notoriety — is the extent to which the famous one straightway becomes an authority in fields wholly unrelated to his specialty. More correctly speaking it is the thoughtless public that pursues the notable and solicits his opinions on all manner of questions of current interest. The press is an avid promoter of this kind of cheap hero worship. In fairness it should be stated that in the beginning it is usually some enterprising newspaper reporter who seizes the opportunity to publicize the doings of an individual simply because he needs a story of some kind for his paper and not because he cares a hang about the actual achievements of his hero of that day. BURBANK was willing to discuss metaphysics and

theology, and HENRY FORD had a sure-fire recipe for world peace. On the other hand General GRANT and MARK TWAIN knew how to reply to inquiries outside of their knowledge and designed to make them ridiculous. One was forceful and profane; the other could neatly turn the tables on his tormentor and make *him* ridiculous.

The public is willing to overlook much in its heroes if their fame has a sound basis. Eccentricities, egotism, and even moral lapses are tolerated. The public cannot love a hero who is a rake in private life but can admire even a Byronesque character if he has real accomplishment to his credit. BURBANK was both loved and admired.

Out of the muck of charges and counter-charges pertaining to BURBANK's achievements, the following facts may be recorded in his favor: that he produced or introduced (1) a variety of potato that was in great favor all over the United States for thirty or forty years, and after a lapse of seventy years is still planted; (2) a dozen plums and prunes that have survived the test of half a century and continue to be popular for both market and home use in many parts of the world — particularly in California and South Africa where several of them are leaders for shipping purposes; (3) several kinds of vegetables that were more or less planted for ten to twenty years; and annual and perennial flowers, some of which enjoyed favor much longer than is the average life for such things. His most notable accomplishments in the development of useful varieties of flowers were with lilies, cannas, roses, amaryllids, dahlias, daisies, gladioli, Richardias, Hemerocallis, Watsonias, poppies, Tigridias, and verbenas.

BURBANK introduced over 250 varieties of fruits alone. These consisted of 10 varieties of apples, 16 blackberries, 13 raspberries, 10 strawberries, 35 fruiting cacti, 10 cherries, 2 figs, 4 grapes, 5 nectarines, 8 peaches, 4 pears, 11 plumcots, 11 quinces, 1 almond, 6 chestnuts, 3 walnuts, and 113 plums and prunes. While he collected cacti that were practically spineless — DAVID FAIRCHILD, the explorer, sent him one — he definitely did breed a type of his own that was free of spines and bore only a few more or less harmless spicules.

Of all his fruits, the plums were his greatest contribution. Twenty varieties of his plums — eighteen per cent of his total output — are still widely planted throughout the United States and other countries. Ten of the number are standard shipping varieties wherever Japanese plums can be grown, as in California, South Africa, Argentina, and Australia. In California alone they form the basis of a huge industry. At present there is a total of about 24,000 acres of BURBANK's plums, which means upwards of 2,000,000 trees. Thousands of carloads are shipped annually and the returns run into the millions.

The exact number of new strains and varieties of plants introduced by BURBANK during a span of fifty years is not known and is difficult to determine at this late date when so many of them have disappeared. However, the number is over eight hundred.

Florists and gardeners regard ten years as the approximate average life of new varieties of flowering plants that appear upon the market, when they are superseded by something better in some respect or because there is a change in the public taste. And a variety must possess real merit to endure that long. Many do not and BURBANK's productions were no exception. On the other hand, some of his things are still offered for sale by dealers after forty years have gone by.

The botanist will be interested to learn that at one time or another during his lifetime BURBANK performed selection or hybridizing experiments with almost 200 plant genera. The exact number so far as can be determined with a fair degree of certainty from his published writings was 188, but probably there were others. No attempt has been made to reckon the number of species involved. Usually there were 1 to 3 species from each genus but five or six were not uncommon. *Lilium* was an extreme instance in which 20 species were employed. It must suffice to say that species from 121 genera yielded varieties and strains that were deemed worthy of introduction, while his studies on 67 genera were barren of practical results.

For these concrete accomplishments and because he was the ferment that stirred others to advance the science of breeding, an intangible achievement, to be sure, but his greatest from the viewpoint of science, he is definitely entitled to a place in the hall of fame; but, all factors duly considered, the best that I can do is to assign him a front seat among the minor prophets, a front seat because of the unusual fact that here is one prophet, at least, who was not without honor among his home people.

Florists and gardeners regard ten years as the approximate average life of new varieties of flowering plants that appear upon the market, when they are superseded by something better in some respect or because there is a change in the public taste. And a variety must possess real merit to endure that long. Many do not and BURBANK's productions were no exception. On the other hand, some of his things are still offered for sale by dealers after forty years have gone by.

The botanist will be interested to learn that at one time or another during his lifetime BURBANK performed selection or hybridizing experiments with almost 200 plant genera. The exact number so far as can be determined with a fair degree of certainty from his published writings was 188, but probably there were others. No attempt has been made to reckon the number of species involved. Usually there were 1 to 3 species from each genus but five or six were not uncommon. *Lilium* was an extreme instance in which 20 species were employed. It must suffice to say that species from 121 genera yielded varieties and strains that were deemed worthy of introduction, while his studies on 67 genera were barren of practical results.

For these concrete accomplishments and because he was the ferment that stirred others to advance the science of breeding, an intangible achievement, to be sure, but his greatest from the viewpoint of science, he is definitely entitled to a place in the hall of fame; but, all factors duly considered, the best that I can do is to assign him a front seat among the minor prophets, a front seat because of the unusual fact that here is one prophet, at least, who was not without honor among his home people.

XIX

SUMMARY OF BURBANK'S PRODUCTIONS

THE persevering reader may desire more particulars than have been given regarding BURBANK's output as a plant breeder. To meet this hypothetical demand, I submit a summary of his more important productions, taken from my technical report, *Luther Burbank's Plant Contributions,* recently published by the University of California.[124]

FRUITS:—

Apples.—Ten varieties, mostly selected seedlings, were announced. Two of these, the **Goldridge** and **Winterstein,** were widely planted in home gardens. The high price, five dollars per tree, no doubt limited their sale. Distributed by BURBANK.

Blackberries.—Of 16 varieties announced, **Himalaya,** a second generation selected seedling from seeds obtained from India, "through exchange", became the most famous. **Paradox, Phenomenal** and **Primus,** blackberry-raspberry hybrids, were much discussed half a century ago, because BURBANK maintained that they should be regarded as new species. The first was an F_4 cross between the Crystal White blackberry and Shaffer's Colossal raspberry. A photograph of the hybrid shows that the fruit closely resembled the modern Boysenberry. The second variety was an F_2 selection from crossing the wild California dewberry (*Rubus vitifolius*), with the Cuthbert raspberry. The fruit resembled the Loganberry. **Primus** was an F_1 cross between the California dewberry, *R. vitifolius,* var. Aughinbaugh, and a Siberian raspberry, *R. crataegifolius.* In commercial cultivation for 15 or 20 years, particularly in Oregon.

The thornless blackberries, the **Santa Rosa** and **Sebastopol,** were unique but never very important. The so-called white blackberries—**Iceberg** and **Snowbank,** the first an F_3 hybrid between Lawton and Crystal White, and the second, one of its seedlings—were distributed throughout the United States by JOHN LEWIS CHILDS of Floral Park, New York. Widely planted by amateurs but never a commercial success.

Blueberry.—The blueberry was hybridized by crossing two species of *Vaccinium,* "one from West Africa and the other from the west coast of America."

---

[124] The full report may be obtained, free of charge, by writing to: Publications Secretary, Agricultural Experiment Station, Berkeley 4, California, and asking for Bulletin No. 691.

Cactus.—For several years BURBANK maintained a large collection of cactus species, mostly belonging to the genus *Opuntia*, which he collected from various parts of the world. Mexican species predominated. This was one of his largest breeding projects. Existing photographs show vast collections of seedlings. Close-up views disclose much variation in size and shape of slabs as well as degrees of spininess. The breeding objectives were fruit and forage. Many varieties served both purposes. To be suitable for forage the spines had to be eliminated. This was accomplished to a high degree, several varieties being practically spineless and a few entirely so. This extreme condition, so far as I am aware, does not occur in nature. Marked betterment was effected in improving the fruit but the best fruiting varieties were apt to be possessed of at least some spines. Altogether 69 varieties were introduced, 35 being recommended for their fruit and 34 for forage. Cacti for forage enjoyed only a brief season of popularity, although fruiting varieties may yet be found in private gardens, but the names are usually lost. This is regrettable, as many of them possessed real merit.

Cherries.—Between 1900 and 1914 ten varieties of cherries were announced. One, the **Burbank**, a seedling of the Early Purple Guigne, proved to be of lasting value as an early shipping variety. Apparently BURBANK did not practice back-crossing with cherries, merely selecting what he considered to be the most promising plants from the F_1 seed bed and grafting them upon the branches of an old tree. When they fruited the final selections were made.

Nectarines.—Some attention was given to nectarines and at least 5 varieties were introduced but interest in the project seems to have been desultory.

Peaches.—Although eight varieties of peaches were announced and one or two were rather widely planted by amateurs, peach breeding was far from being a major interest. In view of the possibilities for peach improvement—amply demonstrated by others during the last 10 or 15 years — it is strange that BURBANK neglected this field. The only explanation I can offer is that he was not amenable to advice from persons who were familiar with market demands. In extenuation, it might be added that his energies were being directed toward things that promised more spectacular results.

Pears.—BURBANK did not interest himself much in the improvement of our cultivated pears. Rather, on account of his predilection for novelties, he began early in his career to import Oriental pears and use them as the basis for his breeding experiments. Late in his life he did hybridize some of the varieties of the day. Four new varieties were announced but they were not important.

Plums and Prunes.—Horticultural literature will perpetuate BURBANK's name for his enrichment of the fruit gardens and orchards of the world with useful varieties of plums and prunes.

His beginning was something of an accident. He imported his first Oriental plums from Japan in 1885, for the same reason that he brought in pears from China—with the hope of finding an acceptable novelty; and what bonanzas the blood plum of Satsuma and the Botan or Abundance proved to be! These two turned out to be not only excellent varieties which will continue to be planted for years to come, but they served as breeding stock, and through hybridization, their qualities were infused into numerous varieties that were the product of many related species.

While BURBANK is known best as the introducer of Japanese plums, he by no means confined his attention to that species. In all he made use of at least eleven species: *Prunus americana, P. Besseyi, P. domestica, P. insititia, P. maritima, P. Munsoniana, P. nigra, P. Pissardi, P. Simonii, P. subcordata,* and *P. triflora.* From these a total of 113 named varieties were derived, some resulting from simple crosses between varieties representing two species, others being the product of several crosses involving more or less complicated heredities. Only 37 of the more interesting varieties will be discussed here: **Abundance** was a seedling of unknown origin. One of the twelve seedling plums imported from Japan by BURBANK in 1885. Originally called Botan. Name changed in 1897. Perhaps more widely grown than any other Japanese plum, although others have a larger acreage. **Ace,** announced in 1927, is still cultivated in a small way in parts of California.

Alhambra was mentioned by DE VRIES[125] as being a "sevenfold combination" including the species *P. Simonii, P. Pissardi, P. domestica, P. triflora, P. americana,* and *P. nigra.* No record of its having been offered for sale, although it might have been sold without announcement, as many of his things were. **America** was a successful hybrid between *Prunus triflora* and *P. Munsoniana.* Widely planted by amateurs. **Apple**'s exact parentage is not known except that it was an F_2 selection from cross-bred seedlings, with Satsuma and probably Robinson in its line of ancestry. Well known in South Africa.

Bartlett was a cross between Simon (*Prunus Simonii*) and Delaware, a *triflora—Simonii* hybrid. Widely planted throughout the United States, but never popular as a market plum. The **Improved Beach** was probably a selected seedling of the wild *maritima,* or beach plum of the northern Atlantic Coast.

Beauty, a highly successful market variety—one of the most important of the Oriental plums—was "the product of a very complicated heredity including several species." A favorite shipping variety in California and South Africa. **Burbank,** a seedling imported from Japan in 1885, is grown extensively throughout the United States. A leading shipping variety in California and popular in South Africa for fifty years.

[125] HUGO DE VRIES, A visit to LUTHER BURBANK. Pop. Sci. Mon., pp. 329-347, Aug. 1905.

Cazique was similar to Beauty in appearance, but inferior to that variety. Planted in home gardens. **Chalco** was a Simon-Burbank cross. BURBANK said it was produced after twelve years' work in crossing *Prunus Simonii* with varieties of *triflora* and *americana*. Extensively planted but never an important market variety. **Choice** was a seedling of America, the latter a cross between Robinson and Abundance. Important only for home planting.

Climax was a cross between the varieties Simon and Abundance. A highly important shipping variety for 30 years but now on the decline. Still about 1,000 acres in bearing in California. **Combination** was probably a mixture of *triflora, Munsoniana,* and *Simonii.* Extensively planted for shipping purposes for twelve to fifteen years. Now of little importance. **Conquest** was a *Prunus domestica* × *insititia* hybrid, effected by pollinating the French prune or Prune d'Agen, with the bullace or wild plum of France, known there as the *sans noyau* or seedless plum. Several generations of reciprocal crosses were required to produce the **Conquest,** which has only the rudiments of a seed. Much planted by amateurs as a plum but never dried as a prune.

Delaware was a cross between Satsuma and Kelsey. Home use; not known in the markets. **Duarte** resulted from a cross between America (*Prunus Munsoniana*) and Climax (*P. triflora*). A profitable shipping plum in California where 2,000 acres are still in cultivation. **Eldorado** has been grown commercially in California for thirty years. A *triflora-Simonii* hybrid. **First,** BURBANK claimed, was the product of crosses and recrosses between Wild Goose, Hawkeye, Hammer, Milton, Wyant, Wayland and Burbank varieties. Interesting but horticulturally unimportant.

Formosa, a mixture of *triflora* and several other races, was announced in 1907. One of the best and most successful of the Japanese type in all countries where grown. Still important as a shipper in California. **Gaviota,** *triflora* × *americana* (and probably other species), was first introduced under the name of Rice Seed. Still commercially important in California and South Africa. **Giant** was a cross between French (Prune d'Agen) and Pond (more properly Hungarian). Grown in a small way as a shipping plum. Rarely used as a prune. **Golden,** now sold under the name of Gold, came from a seed of Robinson fertilized by Abundance. Introduced by STARK Brothers of Louisiana, Missouri, in 1893. May be found in fruit gardens in many states. **Hale,** a Kelsey-Satsuma (*triflora* × *Simonii*) cross, was originally known as Prolific. J. H. HALE of South Glastonbury, Connecticut, changed the name and introduced it in 1894. Widely planted but not successful—trees not hardy and fruit too tender to ship.

Maynard, a *Prunus triflora* × *P. Simonii* hybrid, was introduced by the Oregon Nursery Company of Salem, Oregon, in 1903. In home gardens everywhere and still listed by nurserymen. **Miracle,** same origin as Conquest, the so-called stoneless plum. Widely planted

as a result of much advertising by the Oregon Nursery Company. **October** (Purple) was said to be a cross between Satsuma and a seedling *triflora.* Introduced by STEPHEN HOYT's Sons of New Canaan, Connecticut, in 1897. Much planted but never important. Still offered for sale by the PICKSTONE Nurseries of Simondium, Cape Town, South Africa.

Santa Rosa, a complex hybrid containing a mixture of *Prunus triflora, P. Simonii* and *P. americana,* with the *triflora* characters predominating. Exactly what varieties were involved in the crosses may never be known but the red flesh would indicate that Satsuma played a part. The Santa Rosa and Beauty are not only the two most valuable varieties wherever Japanese plums are grown on a large scale—as in the United States, Southern Europe, North Africa, South Africa, Australia, and New Zealand—but they are the leaders among shipping plums of any variety. There are over 5,000 acres of Santa Rosas under cultivation in California alone. The Santa Rosa was introduced by GEORGE C. ROEDING of the Fancher Creek Nurseries, Fresno, California, in 1906. The Australian rights were secured by J. M. RUTLAND of Kiewa, Victoria, and the South African by H. E. V. PICKSTONE and Brother of Simondium, Cape of Good Hope.

Satsuma was one of twelve seedling plums imported from Japan in 1885. It was called the Blood Plum of Satsuma, after the province where it was grown. Introduced by BURBANK himself. The first trees were sold in 1889. Unattractive appearance has mitigated against the Satsuma as a shipping plum; but quality and true worth have given it supreme importance in local markets and home plantings. **Shiro** was a combination of Robinson (*Munsoniana*), Myrobalan, (*insititia*), and Wickson (*triflora*). A seedling of Wickson. Known in South Africa as Shiro Smomo. *Triflora* characters predominate. Planted in home gardens in many states.

Splendor Prune was a cross between two varieties of *Prunus domestica,* Pond (Hungarian) and French (Prune d'Agen). Introduced by STARK Brothers of Louisiana, Missouri, in 1886. A successful plum but objectionable as a prune. **Standard Prune,** also a pure *Prunus domestica,* was a cross between the Tragedy and Sugar prune varieties. A fine combination of drying and shipping plum, but more successful as a plum than as a prune. **Sugar Prune** was another *domestica,* being a seedling of French (Prune d'Agen). A heavy producer. Extensively shipped as a plum. Used in California, also, as a prune. Noted for its high sugar content both fresh and dried.

Wickson, a *triflora* × *Simonii* hybrid, is widely distributed over the world wherever Oriental plums can be grown. Quality second rate. On the decline in California although in 1940 there were still 2,000 acres under cultivation.

Most of the seventy-eight additional plum varieties, not mentioned here, were undoubtedly planted to some extent as there were scores, if not hundreds, of BURBANK admirers who made a practice

of securing at least one specimen of nearly everything he announced. Also, from around 1900 to 1915, BURBANK's fame was so great that nurserymen, both here and abroad, purchased the exclusive right to disseminate several of the varieties on the omitted list; and since in all cases these varieties were vigorously advertised, it is reasonable to assume that they were planted, and in far-away places some of them may have made good. They are omitted here because we have no evidence that they survived.

Plumcots.—This interesting hybrid was produced by crossing the apricot, *Prunus armeniaca*, with the Japanese plum, *P. triflora*. Reciprocal crosses were also made, although the apricot was usually the pollinating parent. Some hybrids had flowers devoid of pistils and often the hybrid seeds were not viable. Many of the trees were weak and almost barren. Others were just "poor producers," or the fruit was discouragingly small, or of inferior quality. Improvements were slow because viable seeds were scarce. Most of the successful hybrids came from plum seeds.

Although the plum-apricot hybrids were announced in 1901, their defects prevented their being offered for sale until several years later. One shortcoming, apparently common to them all, was that they were shy bearers. BURBANK described the plumcot as having "the general form of an apricot and the same general outside appearance, but often more highly colored than either a plum or an apricot, with skin unique — soft, slightly silky-downy, with a shadowy bloom. Seed more often resembles the plum pit, but sometimes vice versa." Eleven varieties were announced.

Abundance. From a color photograph it is seen that the flesh resembles the Satsuma plum. The description reads: "The fruit holds the apricot shape and has the short stem and blossom-end of the apricot. In other fruit characters it resembles the plum parent —the serrations of the leaf, however, being those of the apricot." No record of its having been offered for sale. **Apex,** a cross between an apricot and a Japanese plum, was announced in 1911. Fruit large and handsome; trees shy bearers. Now regarded as a Japanese plum. Often met with in California but never commercially important.

BURBANK said of the **Cherry** plumcot: "This beautiful fruit is a curious combination. The fruit itself is a true plumcot, whereas the stem and leaves are distinctly those of the plum." A color photograph shows it to look like a well-colored cherry plum.

TEXTFIGURE 6. — COVER OF A 16-PAGE CIRCULAR, containing the first important announcement made by Mr. BURBANK after he took back the right to market his productions following the disastrous failure of the Luther Burbank Company of San Francisco, the firm that had contracted some three years before to purchase everything that he could produce. Comparatively few people, even in California, knew that BURBANK had no connection with this corporation—owned no stock in it—and therefore should not be blamed for its sales policies. He permitted the use of his name in much the same spirit that he allowed schools, libraries, and playgrounds to be named after him. Incidentally, the city of Burbank, California, was *not* named in his honor, but for a man of that name who had formerly owned the site.

1916 - 1917

TWENTIETH CENTURY FRUITS

At this date, November 15th, there have been grown and shipped out of the State of California *this season ONE MILLION, ninety-two thousand, two hundred and fifty-six crates* of plums and cherries alone of varieties which were created on my own grounds, *besides* one large shipping firm which could not make a variety report. Need more be said in regard to the value of my horticultural creations?

Some *SEVEN MILLION BUSHELS* of *Burbank Potatoes* were also grown here this season, and unnumbered carloads of *Rhubarb, Prunes,* and other horticultural products can be added for good measure.

LUTHER BURBANK

Burbank's Experiment Farms Santa Rosa, California

Rutland was named for J. M. RUTLAND of Kiewa, Victoria, Australia, who purchased the rights for this variety for the Southern Hemisphere, including South America. The next year the rights for the United States were sold to GEORGE C. ROEDING of the Fancher Creek Nurseries, Fresno, California. BURBANK believed the Rutland to be a cross between an apricot and the Satsuma plum. It is now definitely regarded as a large hybrid plum of poor quality.

Quinces.—Eleven varieties of quinces were announced. Three of them are still in cultivation. One has survived for fifty years, and another for forty-five years.

Childs was introduced in 1893 by BURBANK as Santa Rosa, but JOHN LEWIS CHILDS of Floral Park, New York, having purchased the rights to its distribution, named it after himself. A seedling of Rae's Mammoth. Believed to be a third generation cross between Rae's Mammoth and Portugal. **Pineapple** was a seedling of Rae's Mammoth and it was claimed that it was the result of fifteen years of selective breeding. The flesh has a pineapple flavor. H. A. BASSFORD of California sent shipments to eastern markets as early as 1910. The variety is still sold by nurserymen. **Van Deman** was a seedling of Portugal pollinated by Orange. Introduced by STARK Brothers of Louisiana, Missouri, in 1893. Named in honor of H. E. VAN DEMAN, Pomologist of the United States Department of Agriculture. First exhibited at a meeting of the American Pomological Society in Washington, D. C., in 1891, where it was awarded the Wilder Medal. Still a popular variety wherever quinces are grown.

Raspberries.—Thirteen varieties were announced, four of them unnamed. There is no record of what names were given them by nurserymen who purchased distribution rights. A native wild black-cap was collected in Mendocino County, California, and named for that county, and another, a *Rubus capensis*, was imported "by way of New Zealand and South Africa and is probably the one that STANLEY speaks so highly of as growing in places on the Dark Continent." The rest were mainly crosses between Gregg, Shaffer and Souhegan.

Strawberries.—Although ten varieties of strawberries were announced, none became important. Experiments consisted of crossing many of the common cultivated varieties of the day; also hybridizing numerous wild species from this and other countries. *Duchesnea indica*, a more or less ornamental species supposed to have come from India, refused to hybridize with any of the true strawberries. Species from Norway and Alaska, and two wild forms native to California—*Fragaria chiloensis* and *F. californica*—were used in different combinations with cultivated varieties, without profitable results.

Patagonia was a much advertised variety derived from crosses between a Chilean species and Brandywine, Longworth's Prolific, Monarch, and Marshall. BURBANK says: "No striking results were observed until the second generation, when among the

very numerous hybrid seedlings under test was found this unique berry." Testimonials acclaimed its qualities in flattering terms, but apparently it was planted only by amateurs.

Sunberry.—Produced in 1905—an F_2 hybrid between *Solanum guineense,* the staminate parent, and *S. villosum,* the pistillate parent. Both were inedible species though not poisonous, while the fruit of the hybrid proved to be pleasing to the taste when cooked but less so when consumed raw, unless thoroughly ripe. Introduced by JOHN LEWIS CHILDS of Floral Park, New York, who changed the name from Sunberry to Wonderberry. Lurid advertising caused the plant to be widely planted by amateurs but it never became a market commodity. Still sold as a novelty under different names.

NUTS: —

Almond.—A variety of almond named **Palatine** was announced in 1911. It was a seedling of the Jordan grown from meats imported from Spain. Much planted in California over a period of several years, but now rarely met with.

Chestnuts.—Six varieties were announced. **California Golden,** a selected seedling of *Castanopsis chrysophylla,* a native chinquapin of the northern coastal region of California, was put out in 1894. It is not certain whether BURBANK referred to the giant chinquapin that occurs among the redwoods, or to the variety *minor*—the golden chinquapin—a shrub 3 to 15 feet high, found along the dry ridges adjacent to Monterey Bay. **Coe,** *Castanea crenata,* 1893, was one of three unnamed seedlings purchased by Judge A. J. COE of Meridan, Connecticut, who called one of them the 18-Month. Soon afterwards the seedlings came into the possession of J. H. HALE of South Glastonbury, Connecticut, who changed the name of 18-Month to Coe, and introduced it under that name in 1897. The other two were named **Hale** and **McFarland.** All three seedlings were dwarfish, the Coe exceedingly so, and in addition, precocious, actually bearing the second year after planting. All three bore sweet nuts, were widely planted, and have survived to the present day.

Walnuts.—From 1877 to 1895 BURBANK gave much attention to the improvement of walnuts. He made use of the black walnut of the eastern United States, *Juglans nigra,* the California black walnut, northern variety, *J. californica* var. *Hindsii,* the Persian or cultivated walnut, *J. regia;* the Asiatic species, *J. Sieboldiana* and *J. mandschurica;* the butternut, *J. cinerea;* "and a dozen or more other species." Two of his hybrids became famous. **Paradox** was the result of a cross between *Juglans regia* and *J. californica,* var. *Hindsii.* The Paradox was first mentioned in *Pacific Rural Press,* February 12, 1887, but was first announced in 1893 when the hybrid was offered for sale by BURBANK in the first edition of his *New Creations.* By a typographical error the date was given as 1887 for the original cross instead of 1877, and this date was copied far and wide. DE VRIES, in his *Plant Breeding,* even gives a date as late as 1901. The foliage of the hybrid

is variable, but mostly resembles the *regia,* as do the nuts; the habit of growth is very nearly like that of the *Hindsii.* The trees are characterized by their rapid growth and immense size. For the first few years they flowered but did not produce fruit. At the age of about ten years they began to produce a few fertile nuts; and thereafter they continued to produce, but sparingly. Paradox was recommended as a timber tree and as a rootstock for cultivated walnuts. It was never popular for the latter purpose; its seedlings vary extremely in vigor and in succeeding generations the hybrid vigor is lost; therefore, only first generation seedlings are suitable for this purpose. While the trees have not been planted for timber, the possibilities seem great.

Royal, a cross between *Juglans californica* var. *Hindsii* and *J. nigra.* The tree is of noble size, and symmetrical in shape. It resembles both parents but is much larger than either. The nuts are like the *nigra* but larger. Royal is an abundant bearer. A single mature tree may produce a ton of nuts in a season. About 1885 five of the first of these hybrids were planted in and around Santa Rosa, California, in different soils. At least two are still living. One is 3½ feet in diameter at breast height, and 100 feet high, with a branch spread of 125 feet. The Royal will find its greatest usefulness as a timber tree. Introduced in 1906 by the Fancher Creek Nurseries of Fresno, California.

Santa Rosa Soft Shell was the result of a cross between two Persian walnuts of unknown ancestry—one locally famous for its heavy bearing, and the other for its thin shells. There were two types of the Santa Rosa Soft Shell, one of which bloomed early and the other late. Both had soft shells, and possessed considerable merit. Introduced by the Analy Nurseries of Sebastopol, California, in 1906.

GRAINS, GRASSES AND FORAGE PLANTS: —

Aside from cactus, BURBANK did not go in heavily for forage plants, grasses, and grains. Beginning about 1907, more than fifty cactus varieties were turned out in four or five years. Approximately half were recommended for forage and half for their fruit, although the latter could also be used for forage if free from spines. As the cactus varieties passed out of BURBANK's hands, a period of wild speculation ensued. Desire for quick profits caused worthless varieties to be sold, thus discrediting the entire industry. By 1916 the craze had subsided.

BURBANK's list of grains and grasses was comparatively short; but the announcement of his grains, in particular, caused him to be severely criticized, state and federal agronomists charging that two or three of them were old, discarded varieties that had been renamed.

Barley.—In 1920 BURBANK offered for sale an old, but practically unknown variety—the **Pearl,** a so-called white barley, from one of the Eastern Mediterranean countries. His **Blue Arabian**

Hull-less was probably a selection from a cultivated variety in Syria or Turkestan.

Cactus—forage.—Cactus enjoyed some success as a succulent feed for poultry and dairy cows. At least there were many published testimonials to this effect between 1906 and 1913. Cattlemen in the semi-arid states of Texas and Arizona had long used wild cactus as an emergency feed in drought years, by singeing off the spines with a blow-torch. BURBANK reasoned that cactus without spines should have unlimited possibilities, and while he produced varieties that were entirely smooth, or so nearly so as to make the name "spineless" no misnomer, cultivated cactus was never planted in a large way. Speculators, by their extravagant claims and high prices, spoiled the industry before it really got started. While cactus for forage never had a fair trial, it is highly probable it would not have been a success. Contrary to general belief it was of slow growth in poor soils and where the annual rainfall was less than ten or twelve inches. Also it had to be fenced to prevent livestock from eating it into the ground. If it had to be planted on fertile soil, fenced, and irrigated, even with high yields, it became unduly expensive for a feed that was mostly water. In short, cactus for forage was an impractical crop, and perhaps never could have succeeded on a large scale.

Of the thirty-four forage varieties announced, the **Avalon** was one of the best in every way. Its history is not known. It may have been an importation. **Burbank Standard** was a product of selective breeding. **Competent** was said to be a second generation, smooth hybrid seedling that was completely free from either spines or spicules. **Fresno**, belonging to the Indian fig class, was a seedling of an old hardy variety named Smith, but unlike its parent and all its seedlings theretofore, the Fresno was claimed to be free of thorns and bristles. **Monterey** belonged to the "Tapuna or pearly-leaved" class of Opuntias, "and has the largest and heaviest pads, slabs or leaves, of any of this class in my whole collection and wholly free from spines except rarely a few short ones here and there." Distributed by American Cactus Farming Company of Los Angeles, California, in 1907. **Myers** was believed to be a natural cross between the "Tapuna" and Indian fig types. Discovered by FRANK N. MYERS near Irapuato, Mexico. Said to be absolutely free from even the least trace of spines.

Santa Rosa belonged to the Indian fig class and was BURBANK's highest priced variety. "One leaf of this with the right to sell in the Southern Hemisphere, including all of South Africa, has been sold to JOHN M. RUTLAND of Melbourne, Australia, for one thousand dollars." Distributed here by the American Cactus Farming Company of Los Angeles, California. BURBANK claimed that the **Texas** was "developed here on my farms from a wild, thorny, Texas plant, wholly spineless." **Titanic** was "one of the most remarkable of all known hybrid spineless Opuntias. Leaves or slabs, often three to nearly four feet long, eighteen inches wide and one and one-half to three inches thick."

Oats.—Four varieties were announced but none ever became important. Apparently no hybridization was practiced. **Corriente** was a selection from a sample imported from Peru.

Quinoa.—**Gautli** or **Quinoa** probably was imported from Brazil or Peru, and first offered for sale in 1887, as an Indian food novelty. In 1918, BURBANK's business ethics having undergone a change, he dramatized the Quinoa by calling it a "new breakfast food, a forgotten cereal of the ancient Aztecs." It had just the right background to attract the gullible, like wheat from Egyptian mummies, beans from the cliff dwellings. Before 1912 BURBANK probably would have hesitated to push the sale of such a plant but in 1918 he took advantage of the free publicity irresponsible writers had given him and promoted it vigorously.

Rye.—The two varieties of rye offered probably were selected from Turkish varieties. This was in 1920 and 1921, at a time when he appeared to be using the prestige of his name to sell things of doubtful value.

Teosinte.—BURBANK developed a variety of teosinte by "selective breeding" which he named **Early Harvest**, and classified it as *Reana luxurians*. Since it was an annual, recommended for silage, it must have been *Euchlaena mexicana*, sometimes cultivated in the Southern States as a green forage. Evidently it was not a success as it is now unknown.

Wheat.—In 1918 BURBANK announced three varieties of wheat, **Quality, Quantity**, and **Super.** The first was declared by agronomists to be identical with an obscure Australian variety called Florence. Although he was roundly criticised for his immoderate statements and high introduction price of $5.00 per pound—$300.00 a bushel—Quality proved to be excellent for certain climates, notably the Dakotas, Minnesota, Idaho, and Washington. Authorities now say that it is "the most widely grown variety of white wheat in the North Central States." Distributed by the Pillsbury Flour Mills Company of Minneapolis, Minnesota.

Quantity was an inferior variety that did not survive early tests. It has never been fully identified, although it is believed to have been some old variety. Distributed by H. J. BARKER, nurseryseedsman, Fond du Lac, Wisconsin, in 1918. **Super** was first announced as Burbank but the next year, without explanation, it was advertised as Super. No information was given about its origin. There were the usual excessive claims. It was a good variety but it turned out to be Jones Fife, an old wheat of Russian origin, introduced by the United States Department of Agriculture in 1893. Super was distributed by the State Seed and Nursery Company of Helena, Montana.

VEGETABLES: —

Of the ninety varieties of vegetables BURBANK offered for sale, his potato was the most famous, and most lasting; while his winter rhubarb, also a real accomplishment, was to him the most profitable.

At one time or another he endeavored to improve artichokes, asparagus, beans, beets, cantaloupes, casaba melons, celery, chives, corn (sweet), cucumbers, eggplants, garlic, muskmelons, parsnips, peas, peppers, popcorn, potatoes, radishes, rhubarb, squashes, and tomatoes.

Beans.—"Almost my first experiment in hybridizing," wrote BURBANK in 1912, "was made by crossing the horticultural pole bean or wren's egg, with another variety of pole bean." He tried also crossing the pole bean with the lima. This was in Massachusetts, when he was about twenty-three and before he produced his famous potato. Forty years elapsed before he again interested himself in bean improvement. Nine varieties were announced, chiefly novelties.

Chive.—BURBANK was interested in the chive both for ornament and for food. Knowing the plant to be extremely variable, he obtained a variety from Europe and began selective breeding. The original plants bore dull crimson flowers. After three years of selection a mutant appeared having bright red flowers. Thereafter, "out of thousands of seedlings, nearly all reverted to pink." Turning his attention to improvement of the bulbs, the average size was increased about twenty-fold. It was found to be relatively easy to increase or decrease the odor of the bulbs. Six varieties were announced.

Corn.—Corn breeding was started by BURBANK as early as 1870, when he was growing vegetables for market in Massachusetts. He crossed sweet corn in an effort to produce an earlier variety but failed because he did not continue beyond the first generation. He also crossed yellow field corn with Early Minnesota and other sweet corn varieties with the idea of producing a sweet corn with yellow kernels, for which there was a demand. Promising hybrids were obtained but the work was interrupted by his removal to California in 1875.

Much attention was given to ornamental types of corn. His "rainbow" corn with stripes of four colors, later increased to six, was derived from a variegated corn secured from Germany in 1908. At first only two stalks bore colored leaves. Later, after several generations, when a few stalks appeared with colors that pleased him, he multiplied them rapidly by removing and rooting the suckers. All plants were hand-pollinated and isolated from other corn. He always suspected that his original seed was a hybrid between the common green-leafed corn and the old Japanese variegated corn —*Zea Mays variegata,* which had been known for thirty years. A dozen varieties of corn, in all, were introduced, some as food plants for man or beast, and others chiefly for ornament. **Aurora** was an example of the latter, the result of five or six years of selective breeding. A yellow sweet corn, with colorful foliage, the **Burbank,** was an improved Burpee's Early Bantam sweet corn. The rows of grains to the ear were increased from eight to twelve. First called Improved Early Bantam, then Burbank Improved, then New Ban-

tam, and finally, Burbank. **Burbank's Early Sweet** probably was a selected form of Stowell's Evergreen. Selected for production of two ears to a stalk. **Burbank Field** apparently was the same variety introduced as California Field, and two years later renamed Burbank. No information as to parentage. BURBANK's **World Wonder Sweet** was "derived from Golden Bantam through selection and cross-pollination." **Papago** was a tall-growing, yellow, wrinkled sweet corn recommended chiefly for silage and green feed.

Sorghum Pop.—Announced in 1917 as a cross between Burpee's Improved Stowell's Evergreen and the gooseneck Kaffir corn, the former being pollinated by the latter. The cross was effected about 1912 after numerous earlier trials had failed. The grains from the hybrid ear were planted, but all the resultant plants except two, were like the pistillate parent. The two exceptions ripened two weeks earlier "and were almost true Kaffir corn with compact, crooked, drooping heads, containing many scattering hard, round kernels, also bearing gooseneck drooping ears, somewhat resembling popcorn. The next season all were planted and a new corn, in many respects resembling white rice popcorn, but with more nearly globular kernels was produced, but the ears were branched or many-fingered and bore kernels, not only on the outside, but on the inside of the ears, producing an enormous number of kernels to the cluster. As these had to be crushed to obtain the corn, selections were made of short, stubby ears, which bore kernels only on the outside." It was recommended as a popping corn.

Agronomists have been skeptical of any such cross having been made and say that the so-called Sorghum Pop is only the old Japanese hulless corn. The cross is a difficult one and has not been repeated, but this does not necessarily mean that it cannot be done. The same objection was made regarding the plum-apricot cross but this feat was duplicated many years later by two experimenters, working independently.

Peas.—Forty years ago (1904) BURBANK received an order from J. H. EMPSON, a canner of Loveland and Greeley, Colorado, for a particular type of pea for his trade—something small like the Petite Pois of France, of uniform size, sweet, and reaching the desired maturity all at the same time so that harvesting and hulling could be done by machinery. The contract called for filling the order in six years; but by growing two crops in a season, BURBANK fulfilled his obligation in half the time. The improvement was brought about through six generations of selections, no cross-pollination being involved.

Three peas were submitted for the selection experiments—the Admiral, Alaska, and Horsford, all having been used for canning. The Alaska and Horsford were soon eliminated. The Admiral yielded five sub-types, graded according to size of pea, and all were sold according to number as **Burbank Admiral.** A letter from the company, dated March 31, 1943, verifies the foregoing statements and adds that they have grown from 1,500 to 2,000 acres of the peas, annually, since 1908.

Peppers.—Numerous crosses were made with Chilean and Mexican forms of peppers on our cultivated varieties. Four varieties were announced but they were of no particular value.

Potatoes.—BURBANK's most lasting fame, no doubt, will always be associated with the potato which bears his name. As a young man of twenty-four, BURBANK was a truck gardener near the village of Lunenburg, Massachusetts. As a grower of vegetables for market he was keenly alive to the importance of improvement in various directions, and hybridized a few plants with this object in view. When, however, he planted the fateful seeds that produced his potato he had no ideas, grandiose or otherwise, for bettering the crop. On the contrary, he planted through curiosity—to see what would happen. Early Rose potatoes seldom flowered, so when a seed-pod chanced to appear it was an object of interest. Most observers were content to wonder and pass on, but young BURBANK kept the single capsule that he had seen and planted the seeds, with astonishing results. BURBANK refers to his potato as a discovery—something he came upon by chance. Be this as it may, his good fortune fired his imagination; he resolved to devote his life to the improvement of plants in ways suggested by DARWIN, not merely waiting for chance to throw improvements in his way. Using the proceeds from the sale of his potato, he went to California and in a few years entered upon his lifework. His further efforts with potatoes had no conspicuous results. The Darwin potato, *Solanum Maglia,* a wild, yellow-fleshed species from Chile, was crossed with the common potato. Of the many curious hybrids that resulted, none was valuable enough to be introduced. The *S. Maglia,* however, normally produced unusually large seed-pods; and one of the hybrids bore pods with a tomato-like flavor, which was introduced for its fruit. Crosses were also made with *S. Cammersoni* from the Mercedes River section of eastern Argentina; the Squaw potato from the Southwest, *S. Jamesii;* and an unidentified Mexican species. Finally, about 1895, he hybridized a Pacific Coast variety known as the Bodega Red with the Burbank. This hybrid was announced but never introduced. Eight varieties were advertised.

The **Burbank,** a first generation open pollinated seedling of the Early Rose, originated in BURBANK's garden near Lunenburg, Massachusetts, in 1873, and was introduced in 1876 by JAMES J. H. GREGORY, a seedsman of Marblehead, Massachusetts, who called it Burbank's Seedling. From a single seed-pod BURBANK planted twenty-three seeds. Each grew and produced a cluster of tubers. All but two of the clusters were worthless. One of these was later discarded, while the other was kept and multiplied as rapidly as possible. In 1876 the entire stock was sold for $150 to Mr. GREGORY, who permitted BURBANK to take ten of the tubers with him to California. In his catalog for 1876 GREGORY extolled the merits of the new potato, saying that unlike its parent it is white skinned, instead of pink; that it outyielded all other varieties by actual test; had but few eyes which were sunk but little below the surface; and that "in quality it is firm grained, of excellent flavor either boiled

or baked, is dry and floury, is fine, is all that can be desired," and "that it ranks between the very early and very late varieties."

The Burbank potato has had a truly remarkable career. Adaptable to extremes of soil and climate, it was widely distributed. After seventy years, under this name, it is still important in certain districts—for example, the great Delta region of California—but still more so in the home gardens of half the states of the Union. Today there are several different strains of the Burbank. The Russet Burbank, known to the trade as Idaho Baker, is one of them. Ninety per cent of the crop in the well-known district near Twin Falls, Idaho, in 1940 were of this variety. Others are the Netted Gem, Klamath and the Pride of Multnomah.

Rhubarb.—BURBANK performed a notable service with a food plant by importing a winter-growing rhubarb from New Zealand and improving it by selective breeding and by crossing it with "the various races of ordinary rhubarb, in particular with the variety known as the Burbank Giant. The crosses were made mostly by using the winter rhubarb as the pistillate parent, but reciprocal crosses were also made. The progeny, as is often the case with hybrids, showed great vigor of growth."

The improved, winter-growing rhubarb was widely grown in countries with a mild climate as in California, England, Italy, and South Africa, and was even taken back to New Zealand and Australia. Several varieties were announced over a period of twenty years, but not being hardy, they were not useful in cold climates.

BURBANK voiced the theory more than once that plants removed from one hemisphere to another, especially to places where seasons are reversed, tend to change their growth habits. This was the explanation he gave for the behavior of the Australian rhubarb which he obtained from New Zealand. H. S. WILLIAMS, chief editor of his autobiography (who should have known better), piled sophistry upon sophistry in an effort to prove that the rhubarb, when removed from the Antipodes, was compelled to follow the calendar rather than the immutable seasons. BURBANK casually mentioned this theory but WILLIAMS devoted pages to it. Nonsense of this kind tended to discredit BURBANK with men of science.

The facts appear to be that a certain type of rhubarb had always grown in the cool season of the winter months—June to September in Australia and New Zealand, and when brought to California it still grew in the winter months which, in this hemisphere, are December to March. We have many plants that demand a low temperature for their best growth; the Australian-New Zealand rhubarb is merely a pronounced example of this kind.

Australian Crimson Winter. The original stock was obtained from D. HAY and Son of Auckland, New Zealand, about 1895. Insignificant at first, it was rapidly improved by selection alone. E. J. WICKSON, Professor of Horticulture in the University of California during the BURBANK era, in his book *California Vegetables* (p. 279), said of it:

"The Crimson Winter, introduced from Australia [?] by LUTHER BURBANK about 1895, and sold by him to the trade in 1900, has revolutionized rhubarb growing in California by completely reversing the market season. This variety and its improvements by Mr. BURBANK and by others who have practiced selection since he sold it out, notably by J. B. WAGNER of Pasadena [California], has multiplied the rhubarb acreage of the state and vastly increased the serviceability and commercial suitability of the plant. It has precluded forcing in California and promises to render forcing unprofitable even in the wintry parts of the country because of the large supplies of open air rhubarb which are available for shipment from this state at all times of the year when the summer varieties grown in wintry climates are unproductive."

Because growers have made their own improvements, developed new varieties best suited to their own soils and climate, and given new names to these variants, the Burbank rhubarbs, even in California, are now rarely heard of, although some modern varieties are probably lineal descendants. JOHN LEWIS CHILDS of Floral Park, New York, was one of the early distributors of BURBANK's rhubarbs.

Squashes.—Work with the squash began as early as 1873 and consisted of hybridizing experiments with the Canada crook-neck, which was then popular. No important improvements were effected. Many years later squash seeds were received from a collector in Chile. As a result of hybridization and selection, two varieties were announced. Gourds from Australia and South America were experimented with but no varieties were perfected.

Tomatoes.—Some hybridizing and much selection was done with tomatoes. Seven varieties were announced. One, a special purpose variety—for preserving—was carried in stock by a nationally known seed company for more than ten years. This was the variety called **Burbank Preserving**.

ORNAMENTALS: —

Of the several hundred ornamental plants introduced by BURBANK, the Shasta daisy was undoubtedly his greatest contribution. This flower has travelled around the world, being widely planted in European countries, South Africa, and elsewhere. In modified form it is still as popular today as it was when first announced nearly forty years ago.

For sheer number of varieties developed through hybridization and selection, within a single genus, *Amaryllis, Hippeastrum* and *Crinum* hybrids easily stand at the top of his list of introductions, followed by lilies, including *Hemerocallis;* then by Watsonias, poppies, gladioli, dahlias, and roses, somewhat in the order named, though none ever became so famous as the Shasta daisy.

The average life of a flowering annual, or even a bulbous or herbaceous perennial—the period dealers carry it in stock—rarely exceeds ten years; then usually it is superseded by an improved type under another name. Dealers are ever on the lookout for new

things to offer their customers; for one reason, because they are more profitable; and their breeders strive to meet this demand.

Scores of BURBANK's hybrid ornamentals were sold to the trade without names. The dealers supplied names of their own selection, and thus the origin of the varieties was lost, so far as credit to BURBANK is concerned. Certainly it is now impossible to trace these transactions.

Amaryllis.—*Hippeastrum, Crinum,* and *Sprekelia* are all included under this heading. BURBANK gave active attention to this group throughout twenty to twenty-five years and watched some of his hybrids even longer. The Hippeastrums were the first group experimented with — *H. Johnsonii, H. vittatum,* and *H. reginae.* The *H. Johnsonii* is itself a hybrid, so that a cross between it and *H. vittatum* (one of BURBANK's early successes), represented a union between a hybrid and one of its parents. In the next generation *H. aulichum* was introduced and then *H. reginae,* the other parent of *H. Johnsonii.* Beginning with the fifth generation, BURBANK tells us: "several other species of *Amaryllis* were introduced into the combination." There were then crosses and re-crosses among the various hybrids. After about twelve years, he says, his "colony of mixed hybrids . . . . showed wide departures from any of the ancestral forms." This is the history of his new race known as Giant Amaryllis.

The Amaryllis hybrids were then crossed with *Sprekelia* and *Crinum.* The *Hippeastrum-Sprekelia* cross was at least a partial success: "I have worked on the *Sprekelia* more or less for twenty years. . . . but I succeeded only once in hybridizing the plant, with the production of fertile offspring." Also "only a single hybrid of this union bloomed, but from this a number of seedlings were grown. The hybrid offspring of these plants of different genera had long, narrow, strap-shaped leaves much like those of *Sprekelia* (the pollen parent), but the blossoms were very much larger than those of that plant, and they had very curiously twisted petals, unlike either parent."

Now comes the controversial claim to having hybridized successfully the *Amaryllis* with the genus *Crinum.* "Interesting hybrids were produced by crossing the *Crinums,* not with the members of the Hippeastrum colony (this proving impossible), but with the form of true Amaryllis known as *Amaryllis Belladonna.* The hybrids thus produced were a curious lot. They seemed undecided whether to take on the flat, strap-shaped leaves of the *Amaryllis* or the tunicate leaves of the other parent. The compromise led to the production of a leaf with a long, curious neck." We are not told which species of *Crinum* he used; it might have been either the *americanum, amabile* (*augustum*), *asiaticum, Moorii,* or *longifolium,* for he tried them all.

At this late date, who can say whether the *Amaryllis-Crinum* cross was really effected? Although some have doubted, it was probably made. Dr. GEORGE H. SHULL, who spent nearly five years in Santa Rosa (1904-1909), checking BURBANK's experiments for

the Carnegie Institution of Washington, supports this belief, at least passively. He has kindly supplied a paragraph from his unpublished report, with the comment that he could "only vouch for the fact that the following statement had Mr. BURBANK's approval."

"Another noteworthy hybrid which Mr. BURBANK produced was between *Amaryllis Belladonna* and *Crinum americanum*, the Amaryllis being the seedling parent. While these Amaryllis-Crinum hybrids are of little economic value, they are of much interest scientifically. The leaves of the Amaryllis are flat and strap-shaped, and those of the Crinum are curved and overlapping or rolled together in such a manner as to form a distinct neck to the bulb. In the hybrid the leaves seem to be distinctly intermediate between these two types, being more or less curved at the base and becoming strap-shaped above, sometimes exhibiting a distinct offset between these two portions of the leaf. The flowers are intermediate between the two parents, being smaller than the *Amaryllis Belladonna* and more tubular, but varying through light pink to deep rosy crimson like the Belladonna lily. These curious and graceful hybrids multiplied quite rapidly and are easily grown, but have never borne any seed. Efforts to cross them with the two parents have also been without result. None of these hybrids have been distributed, and only a few remain in existence at the present time."

Apparently only eight or ten varieties of amaryllis were introduced, but a large number of hybrids were announced—136 at one time—and sold without names. Likewise, according to a statement by BURBANK, crinum hybrids were sold without names and without advertising. So far as can be determined, all have now disappeared from the trade or have been further improved and their original names lost.

Martinique. This variety, announced in 1909, was considered to be the finest and most unique hybrid between the Jacobean lily, *Sprekelia formosissima* and *Amaryllis* (Hippeastrum) *vittate*. "The flowers are a fiery crimson—like those of the Jacobean lily but very much larger. The blooms are nine inches in diameter and are even more remarkable for their long, curious, twisted petals, which give the flower a strange appearance and which is not found anywhere among the *Amaryllidaceae*. The leaves are pale green, upright, strap-shaped, one inch wide and eighteen to twenty inches long." He added that seed capsules were produced abundantly but rarely with viable seeds.

Canna.—Ten varieties of canna were announced, of which **Burbank** and **Tarrytown** were the most important. The latter was a hybrid between a canna of the Crozy type and the wild swamp canna of Florida, *Canna flaccida*, and the Burbank probably had the same origin. The Tarrytown was rated as an orchid type and apparently was very popular for a few years after its introduction in 1895. It was awarded a gold medal at the Pan-American Exposition at Buffalo, New York, in 1901.

Clematis.—The well-known *Clematis Jackmanii* was pollinated by *C. coccinea*, and "various other species including *C. Davidiana*,

C. Freemontii, *C. ligusticifolia*, *C. Douglasii*, *C. verticillaris*, *C. occidentalis*, *C. Fortunei*, *C. Viticella*, and others, no attempt being made to keep the various crosses separate."

The varieties **Ostrich Plume**, **Snowdrift**, and **Waverly**, which BURBANK termed his new race of *Clematis*, were the product of crosses between *C. coccinea* and *C. crispa*. Seedlings of the *crispa* were pollinated by various species and showed a great amount of variation in both color and texture of the flowers, but in their general habit, and their herbaceous stems, the hybrids seemed uniformly to follow the seed parent. Introduced by J. C. VAUGHAN of Chicago, Illinois.

Crinum.—"I have grown about twenty species, some of them of tropical origin. Numerous crosses were made among these species until I had a crossbred strain of Crinums of ancestry as complex as that of my Hippeastrums." The seed parent of most of the hybrids was *C. americanum*, but a few were from seeds of *C. amabile* (*augustum*) and *C. asiaticum*. The traits of the temperate-zone species appeared to be dominant.

Dahlia.—Experiments designed to improve the dahlia were of three kinds: crossing cultivated varieties with the cactus dahlia of Mexico, *Dahlia Juarezii*, production of a fragrant dahlia, and attempts at hybridizing the dahlia with the related genus, *Bidens atrosanguinea*, the so-called black dahlia. The first project resulted in several double-flowered varieties; but the perfectly doubled forms were seedless.

A strain with a faint but pronounced fragrance, "comparable to that of magnolia blossoms," was developed by repeated selection. Fragrance, however, not seeming to be "compatible with other desirable traits of flower and form, none of the fragrant-flowered seedlings were named or introduced, except three or four, which were purchased by J. C. VAUGHAN of Chicago," [Illinois], who presumably introduced them under names of his own.

The black dahlia (*Bidens atrosanguinea*) refused to hybridize with true dahlias; but the flowers were reported to have been doubled in size, extra petals added, and the color improved—all by selective breeding.

Twenty varieties of dahlia were named and offered for sale. Two of these—**Lavendera**, introduced in 1918, and **Sebastopol**, announced about 1895, remained a long time in the public favor and, indeed, may yet be found in cultivation.

Daisies.—Creation of a new race of daisies by a process of breeding was one of BURBANK's outstanding accomplishments. The foundation stock was a form of wild *Chrysanthemum*, presumably from New England, but possibly from the Mt. Shasta region of California; this and its seedlings were combined with *C. maximum* and *C. lacustre* from Europe and *C. nipponicum* from Japan. At the outset, improvement by selection alone was tried with the wild daisy, but while there was considerable variation there was no marked advance toward betterment. Pollen of the *C. maximum* was then used to fertilize the most promising of the seedlings.

These hybrids being unsatisfactory, he next introduced *C. lacustre*, obtaining the seeds from a dealer in Germany. This he used as the pollen parent on the best of the hybrids. By selection for "five or six years," he secured a daisy obviously superior to any one of the original forms as to size and beauty of flower and fully equal to any of them in ruggedness and prolific blooming but the flowers still lacked that quality of crystal whiteness he held as an ideal.

The final step in the breeding program was then taken by bringing in the fourth and last member of the combination—the Japanese species, *C. nipponicum*. In most respects, this daisy was inferior to other species, but it had a pure white flower, the only quality that was lacking in all the others. When this was in bloom it was used as the pollen parent in crossing it with the *Leucanthemum-maximum-lacustre* hybrid. The rest of the story was one of continued selection, until at last one was found "with flowers as beautifully white as those of the Japanese and larger than the largest of those that the hybrid plants had hitherto produced." The work was begun about 1884 and completed in 1901. The perfected flower was given the name of Shasta Daisy.

For all practical purposes the Shasta became a new race of daisies. It was an immediate success in this and other countries and is as popular now as it was forty years ago. Of course, it has been greatly improved; but it is still found in flower gardens everywhere in its original form, as first introduced. Seven varieties were introduced, of which **Alaska** and **Westralia** were the most prominent.

Gladioli.—During his lifetime BURBANK introduced over forty varieties of gladioli. He says he first began experimenting with them about 1882. His first variety, although sold in 1889, was not announced until 1892. His last was announced in 1925. The old-time variety, or species, *gandavensis*, and the then new variety America, played important parts in the early hybridization experiments.

BURBANK really made some valuable gladiolus contributions; several of his varieties remained in the trade ten to twenty years or even longer. His first success was a type with a hyacinth-like flower arrangement. This was lost by freezing after being sold. Discouraged by the ravages of garden pests, chiefly gophers, the entire collection of breeding stock was sold to H. H. GROFF of Simcoe, Ontario, Canada. GROFF added many more varieties to the list of fifty-seven already announced by BURBANK.

Godetia.—BURBANK is credited by botanists with having introduced a new species of *Godetia* from Patagonia. His Chilean collector found the plants growing wild in Patagonia. In announcing the plant in 1910 it was given the variety name of **Burbank's New Lavender Trailing** godetia. Botanists accepted the name *G. Magellanica*, which BURBANK had suggested as only a provisional name, for the species. The flowers were lavender-colored, a color not before seen in godetias. It was said that at the first of the

season the plants were trailing in habit, but when blooming became upright, attaining a height of two feet.

Hemerocallis.—Four varieties of day lilies were announced as hybrids, but their parentage was not given. **Burbank** was described as being thirty-four inches tall, and the flowers yellow with rather narrow segments. STOUT says, "Very like *H. Thunbergii.*" Distributed by CARL PURDY of Ukiah, California.

Lilies.—For thirty years or more, beginning about 1875, BURBANK carried on an extensive breeding program with lilies. Besides the true lilies he also worked with *Agapanthus*, the so-called lily of the Nile or African lily; *Alstroemeria*, the so-called lily of Incas, a bulbless lilylike plant with yellow flowers; *Hemerocallis* or yellow day lily; *Herbertia; Richardia* or calla lily; and *Tigridia*, or tiger lily. But it was with the true lilies that he conducted what even today is considered to be, probably, the most extensive lily-hybridizing project ever undertaken. It involved crosses between Old World and eastern American species with wild forms indigenous to the Pacific Coast. The latter were successful parents. CARL PURDY, an authority on Pacific Coast lilies, considered the successful hybrids to be chiefly from crosses of *Lilium pardalinum* with *L. Washingtonianum, L. Humboldtii, L. Parryi,* and *L. maritimum.* The start was made with the wild *L. pardalinum* which was cultivated and the seeds planted. Extreme types of these seedlings were selected and cross-fertilized, the process being repeated several times. Variation in the offspring was wonderful to behold. In a collection of an estimated four hundred hybrids, every intermediate form could be found, from giants nine feet tall to dwarfs from six inches to a foot in height, while the flowers ranged in color from yellow centers and scarlet tips through orange to light yellow centers with pale red tips. "These variations served as a basis for succeeding work", continued PURDY, "for when by repeated cross-fertilizations a form begins to break, it is more susceptible to the influence of the pollen of another species.

"Using some of these varieties of *Lilium pardalinum* as pistillate parents, Mr. BURBANK crossed them upon the following lilies: *L. auratum,* many varieties; *L. Batemanniae, L. Brownii, L. candidum, L. Catesbaei, L. chalcedonicum, L. elegans, L. Humboldtii, L. longiflorum, L. Martagon, L. maritimum, L. Parryi, L. parvum, L. speciosum, L. superbum, L. tigrinum, L. Wallichianum, L. Washingtonianum, L. purpureum,* and some other Pacific Coast lilies were also used as the pistillate parents for a few thousand crosses. . . ."

In retrospect, after half a century, this experiment in hybridization still appears to have been boldly conceived and audaciously executed, especially since knowledge of breeding was limited at the time and since the experimenter was compelled to make his ventures pay cash dividends. From a scientific viewpoint the experiment yielded much information on the possibilities of commingling the characters of an interesting group of American species and at least pointed the way toward introducing some of their virtues, such as perfume and hardiness, into Old World varieties.

According to George L. Slate, author of *Lilies for American Gardens* (1939), none of the Burbank hybrids survived weaknesses that may yet be overcome by a sustained process of breeding to eliminate the virus disease and adapt them to a wide range of soil and climatic conditions.

Burbank's lilies—with one exception—were sold as hybrids without variety names. The one exception, the **Burbank**, a hybrid between *Lilium pardalinum* and *L. Washingtonianum*, probably was named by the introducers, J. J. H. Gregory and Sons of Marblehead, Massachusetts. The hybrids were widely disseminated both in this country and in Europe, but they seem to have succumbed to what is now known as mosaic disease, or become so weakened that the varieties gave a poor account of themselves and were eliminated by discouraged growers.

Nicotiana.—Crosses were made between *Nicotiana alata, N. glauca, N. purpurea* (var. *grandiflora*?), *N. suaveolens, N. affinis* (var. *grandiflora*?), *N. colossea* (*tomentosa*?), and perhaps others. The crosses were effected with much difficulty; all hybrids were infertile and had to be propagated from cuttings of stem or roots. No varieties were introduced.

Nicotunia.—The cross that produced this novel hybrid was between *Petunia hybrida* var. *grandiflora* and *Nicotiana wigandioides* var. *rubra,* the petunia pollen being used to fertilize the *Nicotiana.* No seed was ever produced in the hybrids, but they were readily propagated from cuttings. Mostly they were semitrailing annuals, the tobacco characteristics predominating; yet when held over until the next year they soon began to show the influence of their mixed heritage. The entire stock was accidentally lost by freezing.

Poppies.—Burbank considered the production of a blue-flowered poppy to be one of his minor triumphs as a plant breeder. This was a development of the corn or Shirley poppy, *Papaver Rhoeas,* through several years of selection. The first epoch in selection ended with the introduction of two varieties of improved Shirley poppies. The flowers were double or semi-double, and the petals were crimped and showed black spots. Selection now took a new direction, finally resulting in "a strain in which about one-third of the plants bore flowers of various shades of blue, some smoky or seemingly mixed with black pigment, and others fairly clear, if not bright, blue color." The blue color was never firmly fixed; some of the seedlings always tended to revert to the more familiar colors. A crimson *Eschscholtzia* or California poppy was similarly developed from the common wild yellow form, by a process of selection. He also experimented with the wild *Papaver californicum, P. glaucum, P. somniferum,* and *P. nudicaule.* Twenty-four varieties were introduced.

Primroses, Evening.—Selections were made from a wild evening primrose from Chile, which he called *Oenothera* "America." It was not offered as a new species but as a new variety. He later hybridized

this with *O. acaulis* or *taraxacifolia,* and produced a number of intermediates.

Richardias.—Marked results followed selection experiments with calla lilies, *Richardia albo-maculata* and *R. hastata.* Then he hybridized the two, making reciprocal crosses. Later *R. Elliottiana, R. Pentlandii, R. melanoleuca, R. Nelsonii,* and *R. Rehmanni* were introduced and hybridized with one another and with *R. albo-maculata* and *R. hastata.* There was wide variation in both form and flower among the hybrids. A dozen varieties were introduced, one of them, the **Fragrance,** being noted for its pleasing perfume.

Roses.—Experiments with roses began in the middle eighties or earlier. The first variety was sent out in 1898. Several more followed up to 1918—just how many is not known, but a dozen or more; some were unnamed seedlings, and some may have been sold without being announced. Seeds from a Hermosa type of Bourbon rose, "which rarely bears seed, even in California," were planted and the resultant seedlings hybridized with Bon Silene and others.

Rambler hybrids were produced by crossing the Crimson Rambler with the Empress of India, the Cecile Brunner and "dozens of others." Other breeding stocks were: the white and buff Banksias, *Rosa gymnocarpa, R. chinensis, R. rugosa,* and General Jacqueminot, which were hybridized with Hermosa. Direct and reciprocal crosses between the Persian rose and the Tea, Perpetuals, Banksias, Multifloras, Bourbons, and Wichurianas were complete failures, it being explained that the Persian is completely sterile and therefore never forms viable seeds. BURBANK did not know the exact ancestry of his hybrids, the pedigrees in a few generations becoming so complicated that he did not keep a record of them.

Burbank, named and announced by the distributor, W. ATLEE BURPEE of Philadelphia, Pennsylvania, in his catalog for 1900, was awarded the gold medal as the best bedding rose at the Louisiana Purchase Exposition at St. Louis, Missouri, in 1904. Survived for many years; re-introduced by STARK Brothers of Louisiana, Missouri, about 1936.

Santa Rosa, a second-generation seedling of Hermosa × Bon Silene. Precocious blooming habit of Hermosa. Introduced by BURBANK himself in 1888. This was the first of his roses to be announced.

Sunflower.—Apparently hybridizing experiments with the genus *Helianthus* were confined to types and varieties of the common sunflower, *H. annuus,* with an admixture of *H. californicus,* with the object of increasing the size of flower and the yield of seeds.

Teosinte.—Burbank's New Rainbow was the only variety announced. Presumably a cross between teosinte and variegated corn, for BURBANK indubitably did make corn-teosinte crosses, as attested by numerous color photographs of the hybrids.

Tigridias.—*Tigridia Pavonia* and its varieties crossed readily with each other and with *T. conchiflora* and *T. buccifera.* Species

of the allied genus *Ferreria*, from the Cape of Good Hope, were also successfully hybridized with the tigridias, but efforts to introduce another genus into the combination—*Herbertia platensis*—was a failure. Five varieties of tigridias were announced.

Tomato.—A cross between the common tomato, *Lycopersicum esculentum*, and *L. pimpinellifolium*, the so-called currant tomato, was announced as an attractive ornamental.

Verbenas.—BURBANK's varieties of fragrant verbena—**Elegance, Fragrance,** and **Mayflower**—apparently were produced by selection alone, through several generations; during which time the flowers were considerably increased in size and the fragrant quality fixed to his satisfaction. This quality, however, was never so firmly fixed as to permit of propagation by seeds. **Mayflower**, the original fragrant variety, originated about 1895, was sold without announcement, to JOHN LEWIS CHILDS of Floral Park, New York, in 1901.

Watsonias.—Several crosses were made between *Watsonia Ardernei* and *W. coccinea*, and their varieties. These crosses and re-crosses resulted in multiple hybrids from which many varieties were selected and introduced from 1908 to 1917. The principal production from *Watsonia* was a pure form with double flowers, wherein the doubling was "brought about, not by the transformation of stamens, as in the case of a double rose, or dahlia, but by growing a new circle of petals outside the old ones . . . . sometimes spoken of as supernumerary doubling, to distinguish it from the usual type in which each new petal takes the place of a stamen." Perhaps the most interesting development from the viewpoint of science was the successful crossing of *Watsonia* with a *gandavensis* type of *Gladiolus*. The hybrids were weak and unsatisfactory, however, and eventually died from "gladiolus diseases." More than a dozen varieties of *Watsonia* were announced.

XX

AFTERMATH

WHEN the press of the nation on April 11, 1926, carried the announcement that LUTHER BURBANK had passed away the question in every reader's mind was, "What is to become of his work?" It was taken for granted that he had some sort of organization that would carry on. The public never has understood that he had no organization — that he worked alone and had no successor. The immediate question that his widow had to find an answer for on that fateful April day was what to do at once. The season's planting was already well under way, for spring comes early in California, but much yet remained to be done. Mr. HALL, who was just finishing his biography of BURBANK, *The Harvest of the Years,* was still at hand and became a valuable helper. He was quartered in the "Studio", an apartment over the garage where he slept and worked.

With the aid of HALL's skilled hands BURBANK's last seed catalog was issued.[126] Presumably BURBANK had already assembled most of the material for the announcement, for it bears a close resemblance in both style and subject matter to catalogs previously issued. Only the introductory statement remained to be written. The brochure also contained an advertisement of the new BURBANK book by HALL which was offered for sale by the Luther Burbank Experiment Farms at Santa Rosa. Then the workers put their heads together and issued a second posthumous catalog under the title, *Final New Fruits Bulletin,* an eight-page announcement of several new fruits that had not before been offered — a pear, ten plums, one nectarine, one prune, and some unnamed hybrid chestnuts. The editors, not being horticulturists, confined their remarks to descriptive statements taken from BURBANK's notebooks.

It should be explained here that WILL HENDERSON, garden foreman, who had been in BURBANK's employ for four years, was perhaps the only person left who had much technical knowledge of the enormous collection of fruits and flowers; and he left shortly, as a result of a disagreement, to go into business for himself. Under the circumstances it seemed to be necessary and advisable to close out the business entirely. The bulletin *Burbank Seeds* carried the following announcement: "No one can 'carry on the work of LUTHER BURBANK.' All we could do as regards his seed and bulb business was to follow out the plans he had made for 1926 and for this Bulletin; that much we have done.

[126] BURBANK Seeds, 1926.

"Regarding the perpetuation of his work of plant-breeding and experimentation, his own wishes have been followed and his own plans carried out. To this end Mrs. BURBANK has offered to transfer Mr. BURBANK's experiments, planting plans, and existing experimental trees and plants, together with ample land and equipment for research and experimentation, to the Leland Stanford University of California. The University has expressed a strong desire to accept the offer, and will do so if and when an endowment can be raised to make possible the fulfillment of the plan contemplated."

But nothing came of these plans. President JORDAN of Stanford was friendly to the idea and he was supported by Judge LIEB, a Trustee of the university. Others were openly or covertly hostile, but mostly there was indifference. Apparently the institution made no serious effort to find a patron to donate the million or so that was thought necessary for an endowment. Friends of the idea approached the authorities of the University of California but received no encouragement. Previous to BURBANK's death the Santa Rosa Chamber of Commerce proposed two plans to him for setting up a permanent memorial, one of which called for the purchase of the Sebastopol tract of thirteen acres, where most of his experimental material was grown, but family influence was brought to bear upon him to reject both of them, although he is said to have been greatly disappointed that one or the other could not have been carried out. After his passing, the citizens of Santa Rosa did not renew their efforts in this direction.

After completing the season's work of 1926 with such experienced help as remained, Mrs. BURBANK decided to dispose of everything except land and buildings. The STARK Brothers Nurseries and Orchards Company of Louisiana, Missouri, became the purchaser. The contract was in two parts. On August 23, 1927, they contracted for "the name and good will of the bulb business, all seeds and bulbs in stock, names and index cards of all customers; implements, supplies and all catalog material; cuts, pictures, photographs, variety names, copyrights, trade marks, phrases and slogans used in the business."

Another contract executed September 6 called for "the exclusive right to all uncompleted experiments with fruits at Sebastopol for a period of ten years, including those fruits mentioned in the '*Final New Fruits Bulletin*' which was issued in 1927, but excluding the Royal and Paradox walnut trees." The old Royal tree is at Sebastopol while the Paradox is in the garden at Santa Rosa. STARK Brothers made some arrangement later that gave them the right to market the nuts from these trees.

The second contract also included the right to certain grafts and buds sent to the Armstrong Nurseries at Ontario, California, to be propagated, but STARKS agreed to pay a royalty for every tree sold and to guarantee minimum royalties of $1,000 a year for a period of ten years. STARKS also reserved the right to renew

either one or both of the contracts for terms of five, ten, fifteen, twenty-five, or forty years.

From down payments and guaranteed royalties Mrs. BURBANK realized a total income of $27,000 for the first ten year period. Other royalties swelled that amount.

STARK Brothers' investment in the BURBANK fruits evidently proved to be profitable as in 1937 they exercised their option and renewed the contract for another ten years. The seed and bulb business may have paid out but it is significant that that particular contract was not renewed.

When STARKS took charge of the "Burbank Experiment Farms" in 1927 they employed a competent horticulturist, Mr. JOHN T. BREGGER, to make a careful study of the vast collection of hybrid fruits that BURBANK had under test in the orchard at Sebastopol. Up to date (1942), thirty-four new varieties have been selected as worthy of introduction. These have been given names and patented in Mrs. BURBANK's name under the new United States Plant Patent Law, and STARKS given the right to sell them. Presumably Mrs. BURBANK will continue to collect royalties as long as STARKS see fit to keep their contract alive.

The "Burbank Experiment Farms" consisted of the thirteen-acre Sebastopol place — his main grounds; the old home place of three acres (where he lived with his mother for thirty years); and the "new" place, a four-acre tract across the street to the north where he built a two-story brick residence in 1907, and where he was domiciled to the end of his life. After his passing the unoccupied portions of both tracts were divided into residence lots. The brick residence was converted into a "Burbank School of Business" by parties who leased it for the purpose. Mrs. BURBANK then moved back to the old, original BURBANK dwelling which stands in the garden where BURBANK first attained fame from his experiments. The ancient structure was overhauled and rehabilitated. The interior of the three principal first-floor rooms was finished in walnut cut from Royal and Paradox trees, two of BURBANK's notable hybrids which had grown too large for the garden space and had to be removed. The reception room and the living room were thrown together and in them many BURBANK relics of a personal nature are displayed. The walls are covered with autographed photographs of notables who had visited him. His desk is kept just as he left it with loose papers and a photograph of THOMAS EDISON, which he had been examining the last time he sat there. Open book cases contain his favorite books. Visitors are admitted for a small fee, the proceeds being given to a local charity.

On the south side of the house is a patio with the famous BURBANK greenhouse, and the studio, forming two of its sides. Near the center of this brick-paved enclosure is an old apple tree which bears several varieties of apples, all hybrids developed by BURBANK and grafted by him on the various branches. In fact he was engaged in grafting one of the branches when he was seized

with his final illness. Considerable sentiment, therefore, attaches to the tree as this was the last piece of work his hands performed.

The adjacent garden of about an acre and a quarter, all that is left of the larger area where BURBANK labored for fifty years, was leased to an Eastern seed firm until 1933 when it was donated to the Santa Rosa Junior College. The seed firm used it to grow an attractive collection of flowers which they allowed the swarms of visitors to believe had been originated by BURBANK.

Since the College came into ownership of the property the Service Clubs of Santa Rosa have erected an attractive gateway, as a tribute to the memory of BURBANK. Nearby, on the small tract reserved by Mrs. BURBANK for residence purposes, stands a noble cedar-of-Lebanon tree, beneath which BURBANK was buried. Intentionally there is no headstone or other marker, the tree, which he himself planted, being his monument. The only other large trees in the yard — an area less than an acre in extent — are a fine specimen of Monkey-puzzle (*Araucaria imbricata*) fifty to sixty feet tall and a Paradox walnut seventy to eighty feet in height.

The College uses the garden, and a greenhouse which they have constructed in the background, for practical instruction in horticulture and botany. The gate stands open all day and callers may wander at will but are requested to sign the visitors' book as they leave. Admission is free. Mr. J. B. KEIL, the instructor in charge of the garden, answers questions freely and is a source of reliable information regarding BURBANK productions. Incidentally, he is engaged in the laudable task of collecting as many of BURBANK's creations as can be found, planting them in the garden. Although it is eighteen years since the master gardener, horticulturist and plant-breeder passed away, hundreds of people from this and other countries continue to visit this BURBANK shrine.

While BURBANK led a frugal life he was not stingy. He occasionally indulged in a rampage of buying useless clothing and gewgaws — probably a throw-back to the time when he desired such things and could not afford them — but such sprees never ran into very much money. Habits of thrift had been taught him as one of the cardinal virtues. Fundamentally he deplored waste. He believed in, and practiced, low cost production and he liked as well as the next one to drive a good bargain when he had something to sell, partly as a matter of pride in merchandizing and partly because he persuaded himself that all of his products were of superior merit.

On the other hand he was liberal with his donations to all sorts of worthy causes. Some twenty years before his death when he began to take in real money he quietly invested it in fertile valley land. He never speculated in mines and oil wells. Although, apparently, he did not invest in the stock offerings of the two promotion schemes that bore his name, he did lose considerable money both directly and indirectly because of his dealings with them.

While on occasion he talked hard times and complained loudly of the injustice of having to run a private experiment station for the benefit of the public, and the unfairness of patent and trademark laws that did not protect him from those who bootlegged his products, I firmly believe that it was not money that he craved but *recognition*. Toward the end of his life — the last ten years — there seemed to be some influence that caused him to go out for the money. It was during this period that he quit raising and selling trees, practically ceased his breeding activities, and gave his whole attention to the seed business. He has told us that he did this because there was more profit in selling seeds than in selling trees. And he was making money fast when he died. Twenty years earlier money was decidedly a secondary consideration to the breeding of plants useful to man.

When BURBANK died he owned several farms and fruit ranches, most of the latter not yet in bearing. The Sebastopol tract was good property because of the large collection of hybrid trees and other things. The gardens in Santa Rosa, approximately seven acres — once in the country but now in the interior of a city of 12,000 people — represented a high value, and doubtless he was possessed of other things of value such as intangibles. At any rate his total estate was appraised at a figure in excess of $168,000. This represented an average net saving — a term dear to the New Englander of his day — of over $3,300 for each of the fifty years of his life after coming to California. Not a bad monetary showing for a man who started with nothing and followed his bent even though it led him into strange and unexplored fields. How many of us who blithely criticise can truthfully say that we have done as well?

XXI

THE BURBANK FAMILY

LUTHER BURBANK, son of SAMUEL W. and OLIVE ROSS BURBANK, was born in the village of Lancaster, Massachusetts, March 7, 1849, and died in Santa Rosa, California, April 11, 1926, at the age of 77. He was married to HELEN COLEMAN in Denver, Colorado, September 23, 1890, and divorced her October 19, 1896. On December 21, 1916, he was married in San Francisco to ELIZABETH WATERS, who survives him. He had no children.

In his autobiography[127] LUTHER tells us that his father was married three times — that his mother was the last of the three wives and that he was a thirteenth child; also that he had a younger brother and sister. So there must have been fifteen children in all — an example in mass breeding that he facetiously refers to as having been emulated in his generation with plants rather than with humans. Apparently — as will be seen later — all of the children were borne to the first and third wives, although this point cannot be verified. Two died in infancy, according to LUTHER's own statement, but whether their mother was BURBANK Senior's first or second wife is not clear. Somewhere I seem to have heard that the second wife did not live very long. The children may have been hers.

BURBANK, Senior, appears to have been a man of substance for his day and time. In addition to his farm he also operated a brick yard. Perhaps this accounts for the fact that he lived in a substantial two-story brick house, a more imposing structure than Lancaster Academy (a one-story brick building) where LUTHER received a part of his education.

SAMUEL BURBANK died in 1868. In 1871 the widow moved to Groton — now Ayer — a few miles away in the same county. The family had now dwindled to three children — LUTHER, brother ALFRED and sister EMMA, the others having established homes of their own. Later, LUTHER tells us, he purchased a small tract of land in the nearby village of Lunenburg and started a market garden. He loved plants and probably did a good job growing and selling vegetables but he early developed a greater interest in experimenting than in marketing. His curiosity led him to plant the seeds from a pod that he had noticed ripening on a potato plant. He was particularly intrigued because in his experience he had rarely ever before seen this variety — the Early Rose — in bloom.

[127] LUTHER BURBANK, his methods and discoveries and their practical application, 12: 7-8.

The seeds not only grew but one of them produced a cluster of white-skinned tubers of surpassing beauty of shape and form.

This was like drawing the grand prize in the Irish sweepstakes — a chance in a million. He tried the same gamble again and again throughout his life but never produced another potato of much value. The successful potato was sold to JAMES J. H. GREGORY of Marblehead, Massachusetts, an acquaintance of the family, as he had taught school in Lunenburg about the time the BURBANKS settled near there. GREGORY was not a seedsman but had been literally impressed into the business by his friends, and friends of his friends, all of whom wanted seeds of a superior, but hitherto unknown type of squash, which he had chanced to find growing in a New England kitchen garden. He paid LUTHER $150 for his potato and named it the Burbank. Now after seventy years it is still widely planted. With some extra money in hand LUTHER cut loose from the gardening business and left for California in the fall of 1875.

When in Lunenburg in the summer of 1937 I discovered among the records of the Town Hall a yellowing manuscript entitled "A history of the town of Lunenburg in Massachusetts from the original grant December 7, 1719, to January 1, 1866" by GEORGE A. CUNNINGHAM. Some unknown person had carried the chronicle forward for an additional eight years. Anent the BURBANK family I was privileged to copy the following:

"SAMUEL W. BURBANK, of Lancaster, married in Townsend, 10 October, 1821, HANNAH BALL, born in Townsend 31 October, 1800, a sister of VARNUM BALL (born in Townsend June 30, 1807). They never lived here, but the family is so connected with others here, that I insert it. She died in Lancaster, 17 February, 1840, aged 39 years, 3 months and 17 days. Eight children. He married (2nd) OLIVE ROSS,[128] born in Sterling, 1813, daughter of PETER and POLLY (BURPEE) ROSS. She came to this town with her children in 1871, after his death in Lancaster, 12 December 1868, aged 73 years, and lived in a house near the Methodist Church.

"Children born in Lancaster:

"1. SUSAN E., born 2 September, 1822, died 20 July, 1825, aged 3 years.

"2. SARAH M., born 21 February, 1826, married November, 1846, A. F. KIDDER of Lancaster, where they both died, leaving two children.
1. MARCIA L. and 2, LIZZIE.

"3. HANNAH E., born 5 April, 1828, died 23 March, 1843, aged 15 years.

"4. GEORGE W., born 17 November, 1829, married APPHIE R. BLAKE. Settled in California.

"5. LUCY A., born April, 1831, died 29 May, 1848, aged 17 years, 1 month and 25 days.

"6. HOSEA HERBERT, born 13 October, 1834, married 7 November, 1860, LIZZIE H. ANDERSON, born in Grafton, 1833. Lived in Westfield; one son, HENRY.

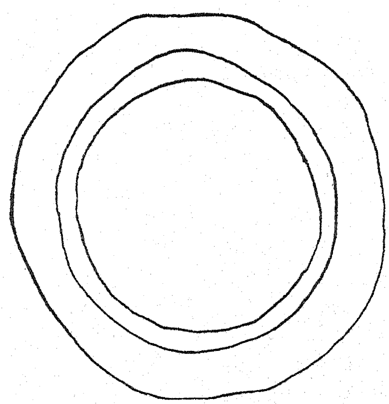
---

[128] OLIVE ROSS was SAMUEL BURBANK's third wife. Historian CUNNINGHAM, or his successor, may not have been well acquainted in Lancaster, which was ten miles away—a considerable distance in those days—or was he ignoring her intentionally as historians have done LUTHER's first wife? He also fails to mention that OLIVE's first two children died in infancy.

"7. Eliza Jenny, born 17 April, 1836, married George Varnum Ball.
"8. David B., born 6 August, 1838, married 20 August, 1864, Paulina V. Ball, born 17 August, 1838, daughter of Rev. Hosea and Sarah (Helmes) Ball. They are—1874—living in California.

"By second [?] wife Olive:
"9. Luther, born 7 March, 1849.
"10. Alfred Walton, born 2 February, 1852.
"11. Emma Louisa, born 20 July, 1854."

While some of the Burbank blood was left in Massachusetts, most of the seed was transplanted to California, where presumably much still remains, but Luther himself, although twice married, did not leave a son or a daughter to carry forward either the germ plasm or the name, which to him must have been a secret disappointment. However, this is mere speculation as there is no record of his having expressed himself upon the subject.



Van Deman Quince.— From Luther Burbank's "New Creations . . . ", p. 11 (1893).

BIBLIOGRAPHY

Unfortunately BURBANK published very little unaided writing about the scientific aspects of his work, especially his philosophy of plant breeding. He was a busy man and preferred to let others speak for him. In 1902 he sent a paper entitled, *The Fundamental Principles of Plant Breeding,* to be read at the International Plant Breeding Conference in New York, which afterwards was published in pamphlet form. *The Training of the Human Plant,* by BURBANK, a pamphlet published by the Century Company in 1907 was well received by the press and pulpit.

New Creations in Plant Life, an Authoritative Account of the Life and Work of Luther Burbank, by W. S. HARWOOD, published by the Macmillan Company of New York, is perhaps the most widely known biography of BURBANK because it has been, and still is, used as a reference book in the public schools. It is highly colored and misleading in its implications. FREDERICK WILLIAM CLAMPETT, in his book, *Luther Burbank, Our Beloved Infidel,* published by the Macmillan Company in 1926, undertook to defend BURBANK's religious views.

BURBANK's scientific attainments were best set forth by the following: *Some Experiments of Luther Burbank,* by DAVID STARR JORDAN, in Popular Science Monthly, January, 1905; *Scientific Aspects of Luther Burbank's Work,* by DAVID STARR JORDAN and VERNON KELLOGG, published in book form by A. M. Robertson of San Francisco, in 1909; *A Visit to Luther Burbank,* by HUGO DE VRIES, in Popular Science Monthly, Vol. 67, pp. 329-347, 1907; and by the same author in his *Plant Breeding — Comments on the Experiments of Nilsson and Burbank,* published by the Open Court Publishing Company in 1907. Of these three authors, the writings of DE VRIES are to be preferred.

The monumental 12 volume work entitled, *Luther Burbank, His Methods and Discoveries and their Practical Application,* was dictated by BURBANK but was edited chiefly by HENRY SMITH WILLIAMS, who faithfully recorded much that was said but at times went farther and interpolated words and thoughts of his own which were unfair to the speaker. Published by the discredited, so-called Luther Burbank Society, the volumes represented the highest form of the printer's art of the time (1914) — deckle edges, ornate binding, hundreds of illustrations in colors — constituted a sizable library of popular reading matter covering the more dramatic episodes of BURBANK's childhood and professional life. *How Plants are Trained to Work for Man,* an 8 volume work, published by F. P. Collier in 1921, was much the same but condensed into fewer books.

Harvest of the Years, by LUTHER BURBANK with WILBUR HALL, published by Houghton Mifflin Company, 1926, is the most entertaining, and at the same time the most informative, BURBANK biography that has, as yet, been put out (a German edition has been published of this!). *Partner of Nature,* edited and transcribed by WILBUR HALL, published by the D. Appleton Company, 1939, gives us no new material. Other and less important references are to be found in the footnotes of the text.

Acknowledgment should be made of the permission, kindly given, to reproduce certain quotations by the Macmillan Co. of New York City (from GOURLEY's "Textbook of Pomology", 1922 and from HYLANDER's "American Scientists", 1935), by the Houghton Mifflin Co. of Boston, Mass. (from HALL's "Harvest of the Years", 1926), by the Haldeman-Julius Publications of Girard, Kansas (from "Address at the Grave of Luther Burbank" by Judge BEN B. LINDSEY), by Charles Scribner's Sons (from FAIRCHILD's "The World Was My Garden"), and by Messrs. Esquire, Inc., of Chicago, Ill. (from FRANK PIAZZI's "Murder by Print" in Coronet, May, 1937).

INDEX

CONTENTS OF CHRONICA BOTANICA, VOLUME 9 (1945)

Position of the Plates

of

Chronica Botanica, Volume 9 (1945)

The title page and other front matter (p. i-vi) of Vol. 9 (1945) will be found bound at the beginning of the first number of the volume.

SPRING 1946 CATALOGUE

The CHRONICA BOTANICA Co.

International Plant Science Publishers

Waltham, 54 — Massachusetts — U. S. A.

CABLES: — Flora, Waltham, Mass.
TELEPHONE: — Waltham 0600
Established in Leyden (Z. Holland) in 1933

PUBLISHERS OF
Chronica Botanica,
'A New Series of Plant Science Books'
AND
Annales Cryptogamici et Phytopathologici

New York, N. Y., U.S.A.,
G. E. STECHERT AND CO.,
31, EAST 10TH STREET

San Francisco, Cal., U.S.A.,
J. W. STACEY, INC.,
244, FLOOD BUILDING

Ottawa, Ont., Canada
THORBURN AND ABBOTT, LTD.,
115, SPARKS STREET

México, D. F., Mexico
AXEL MORIEL SUCRS.,
SAN JUAN DE LETRAN 24-116; APARTADO 2762

Bogotá and Medellín, Colombia
LIBRERIA CENTRAL

Lima, Peru
LIBRERIA INTERNACIONAL DEL PERU,
CASA MATRIZ. BOZA 879; CASILLA 1417

Santiago, Chile
LIBRERIA ZAMORANO y CAPERAN,
COMPAÑIA 1015 Y 1019; CASILLA 362

Rio de Janeiro, Brazil
LIVRARIA KOSMOS,
RUA DO ROSARIO, 135-137; CAIXA POSTAL 3481

São Paulo, Brazil
LIVRARIA CIVILIZACÃO BRASILEIRA,
RUA 15 DE NOVEMBRO, 144

Buenos Aires, Argentina
ACME AGENCY, SOC. DE RESP. LTDA.,
BARTOLOMÉ MITRE 552

Moscow, U.S.S.R.
MEZHDUNARODNAJA KNIGA,
KUZNETSKI MOST 18

London, W. 1, England
WM. DAWSON AND SONS, LTD.,
43, WEYMOUTH STREET

London, W. C. 1, England
H. K. LEWIS AND CO., LTD.,
136, GOWER STREET

Uppsala, Sweden
LUNDEQUISTSKA BOKH.

Groningen, the Netherlands
N. V. ERVEN P. NOORDHOFF,
Chief Agents for Continental Europe

Paris, VI, France
LIBRAIRIE H. LE SOUDIER,
174, BOULEVARD ST. GERMAIN

Torino, Italy
ROSENBERG & SELLIER,
VIA ANDREA DORIA 14

Lisbon, Portugal
LIVRARIA SÁ DA COSTA,
100-102, R. GARRETT

Calcutta, Bombay and Madras, India
MACMILLAN AND CO., LTD.

Johannesburg, South Africa
CENTRAL NEWS AGENCY, LTD.,
COMMISSIONER & RISSIK STREETS;
P. O. Box 1033

Sydney, Australia
ANGUS AND ROBERTSON, LTD.,
89, CASTLEREAGH STREET

Melbourne, C. 1, Australia
N. H. SEWARD, PTY., LTD.,
457, BOURKE STREET

"Probably the most serious question which faces those engaged in scientific work today is the enormous volume of publication . . . It has serious consequences for the scientific worker, because it becomes increasingly difficult for him to be well informed on sciences other than his own—or even of work outside his own particular line of research. This is a very great danger for it must tend towards the disintegration of scientific knowledge as a whole. It promotes narrow specialization, and renders ever more difficult that infusion of new ideas from without which is the original source of great scientific advances. The problem is too serious to be left unheeded. The publication of abstracting journals is of only limited help, for without detailed knowledge of the facts and an estimate of the validity of the methods used, the conclusions of a research are ambiguous, and may be of little value . . . the main source of help for the research worker must be in the publication of comprehensive books. By collecting the available information in encyclopaedic form, it is made far more readily available to all types of readers . . . " (NEEDHAM).

▶ **The Chronica Botanica Co.** was founded in 1933 in Leyden, Zuid-Holland, a centuries old centre of botany, international relations work, and fine printing. In 1940 the company was transferred to the U.S.A. and has since been established near Boston, at Waltham 54, Mass., at 77-79 Sartell Rd. — Practically all of its publications belong to one of the three following monograph series: CHRONICA BOTANICA (*see* page xii), "A NEW SERIES OF PLANT SCIENCE BOOKS" (*see below*), and the ANNALES CRYPTOGAMICI ET PHYTOPATHOLOGICI (*see below*). — The Editors welcome suggestions from correspondents concerning possible future volumes of these serials, remarks about those already published, etc.—Especial prominence has from the first been given to publications which may serve to promote international relations in the plant sciences or in science generally, even if such publications are not too sound from a purely commercial point of view, remote from ordinary experience, and of no obvious economic application.

▶ **"A New Series of Plant Science Books"**, a collection of distinguished monographs of various branches of modern plant science, was established in 1938. About 3 volumes are being published a year at prices ranging from about $4.00-$6.00. The following volumes have been published or are in press: —

▶ **Annales Cryptogamici et Phytopathologici,** our new serial, consists of memoirs (each forming a separate volume), devoted to general and systematic cryptogamy and phytopathology. It continues *Annales Bryologici* (*see below*). About 2 volumes will be published every year at prices ranging from about $4.00-$6.00. The following volumes have been published or are in press: —

▶ Annales Bryologici, a journal devoted to the study of mosses and hepatics, of which we published (in the beginning in coöperation with Messrs. NIJHOFF) 12 volumes and 4 supplementary volumes, between 1927 and 1939, is now being continued by the *Annales Cryptogamici et Phytopathologici* (*see above*). Complete sets and single vols. of *Annales Bryologici* are still available at $4.00 a volume.—The bryological exsiccati formerly issued by Dr. FRANS VERDOORN: Bryophyta Arduennae Exsiccata (dec. 1-5, 1927/29), Hepaticae Selectae et Criticae (11 series, 1930/39) and Musci Selecti et Critici (7 series, 1934/40), have all been sold out.

— ON PUBLICITY AND PAYMENTS —

- *Three times a year* we send copies of prospectuses about recent Chronica Botanica Co. publications, our latest catalogue, lists issued by the Book Dept. (accompanied by handy order forms), to all plant science institutions of the world, as well as to many libraries and individuals. Please advise us if you do not receive this material regularly and are interested in having it.
- We fill *mail orders from any part of the world* without delay.
- Prices subject to change without notice.
- *Detailed prospectuses* are available upon request for most of the titles listed below.
- We pay postage when orders are accompanied by a remittance *in full.*
- Larger selections of Chronica Botanica Co. publications may be acquired *at convenient bimonthly payments.*
- There are now in many parts of the world *regulations in effect which make it complicated to send small remittances to the U.S.A.* Such regulations never prohibit the acquisition of books from abroad. Mostly they include special provisions enabling you to acquire essential scientific texts and serials. Anyone who experiences difficulties of this kind should, if possible, order through one of our authorized agents (*see* p. i) or should ask the advice of a reliable banker or bookseller, who will be able to help in practically all cases. If the difficulties seem unsurmountable write us for further advice. We will find a way to help you.

▶ **The Book Dept. of the Chronica Botanica Co.** issues from time to time lists of certain new books, rare old volumes and sets of periodicals. LIST 1, *'Important Foreign Publications recently reproduced in the U.S.A. under the auspices of the Alien Property Custodian'*, is available upon request. LIST 2, *Recent Biological and Agricultural Books published in North America,* is in preparation.

The Book Dept. of the Chronica Botanica Co. is always glad to receive offers of sets of agricultural, botanical, and horticultural periodicals, as well as of books, pamphlets and prints dealing with any aspect of biological history, biography and bibliography.

► **A complete list, alphabetical by authors (or editors), of all Chronica Botanica Co. publications, including those which are in press and the few which are out of print.** — Nearly all these publications (as clearly indicated) belong to one of our three monograph series, CHRONICA BOTANICA, 'A NEW SERIES OF PLANT SCIENCE BOOKS', and ANNALES CRYPTOGAMICI ET PHYTOPATHOLOGICI. For check lists of volumes of the latter two series by numbers see p. ii. For information and terms of subscription to CHRONICA BOTANICA *see* p. xii (back cover).

► GOETHE'S BOTANY *by* **Agnes Arber**, D. Sc., author of 'Herbals' (Cambridge). — A modern, carefully prepared translation of JOHANN WOLFGANG VON GOETHE'S 'Versuch die Metamorphose der Pflanzen zu erklären' (1790). Many critical notes. A special appendix deals with the fragment known as 'Die Natur', and attributed to GOETHE. — *Chronica Botanica, Vol. 10, No. 6;* Sup. roy. oct., ca. 80 pp., illustrated, *in press, ready autumn 1946*............$2.50

Contents: Introduction. A note on translations. Title page of the first issue of the first edition. Translation. Appendix: The fragment "Die Natur" (prefatory notes and translation).

►FOREST TREE SEED OF THE NORTH TEMPERATE REGIONS *by* **H. I. Baldwin**, Ph. D. (N. Hampshire Forestry Dept.). — The first modern book dealing exclusively with tree seed in English. With a polyglot glossary of tree seed terms. — *A New Series of Pl. Sci. Books, Vol. 8 (1942)*; Sup. roy. oct., buckram, 240 pp., 28 illustr..........$4.75

Contents: Structure and development. Seed production. The importance of seed source or provenance. Seed collection. Extraction. Cleaning and treatment. Storage and longevity. Insects, diseases and other enemies. Germination. Internal and external factors affecting germination. Chemical aspects. Seed stimulation. Different kinds of tests. Purity analysis. Determination of origin. Testing viability without germination. Testing of germination. Seed testing stations and certification. Research. Glossary. Indices.

The material presented is critically examined, well documented, and there are fairly extensive lists of references to literature. Much of the discussion on harvesting, storage, and germination pertains with equal validity to many types of plants, so that the book has a wide field of interest and usefulness beyond the more immediate limits of species of trees (KRAUS *in* BOT. GAZETTE).

The work will be indispensable to research workers in the field of tree seed and very useful to practical foresters and members of the seed trade. It is not a handbook of tree seed, giving cut and dried information about individual species, but a reference book and a guide, not only to existing knowledge but also to the directions in which that knowledge should be extended in the future (THOMSON *in* NATURE).

► PLANT VIRUSES AND VIRUS DISEASES *by* **F. C. Bawden**, Ph. D. (Rothamsted Experimental Station). — *Second entirely revised and modernized edition* with many new illustrations. No chapter remains unchanged, and more than half have been completely rewritten. Recent advances in all branches of the subject are described and correlated. Techniques new to botanists are discussed, special attention being given to work on the chemical, physico-chemical and serological properties of purified virus preparations. Modern concepts on the nature, origin, size and multiplication of viruses are critically reviewed. — *A New Series of Pl. Sci. Bks., Vol. 13 (1943)*; Sup. roy. oct., buckram, 294 pp., 48 illustr..........$4.75

Contents: Symptomatology. Transmission. Relationships between viruses and insect vectors. Virus strains, mutation, and acquired immunity. Serological reactions. Methods of purification. Properties of purified virus preparations. Optical properties of purified virus preparations. Inactivation of viruses. The sizes of virus particles. Physiology of virus-diseased plants. The classification of viruses. Control. Origin and multiplication of viruses.

In recent years students of plant viruses have been joined by workers in subjects which at first sight seem to have little connection with plant pathology. Biochemists, physical chemists, serologists, statisticians and X-ray specialists have all taken a hand in the game and the ordinary biologist finds himself somewhat bewildered by these specialists each talking a jargon of his own. One welcomes therefore the present volume which gives a lucid explanation of much of this unfamiliar technique . . . written in an interesting and readable style and the subject is presented in a coherent and consecutive manner and is not a mere statement of unrelated facts (K. M. SMITH *in* J. PATH. BACT.).

While it is true that the subject-matter is weighted to the plant viruses the fundamental principles of transmission, mutation, immunity, serological reactions, methods of purification, properties, together with the data on inactivitation and size of virus particles here given can well be guides to extension of exploration into similar agents affecting animal tissue and growth. And the discussion on origin and multiplication of viruses should make all biologists furiously to think (HAMMETT *in* GROWTH).

► A SOURCE BOOK OF AGRICULTURAL CHEMISTRY *by* **C. A. Browne**, Ph. D., Sc. D. (U. S. Dept. of Agriculture). — A History of Developments in the Application of Chemistry to the Theory and Practice of Agriculture from the Time of DEMOCRITUS to the Period of LIEBIG. — *Chronica Botanica, Vol. 8, No. 1 (1944)*; Sup. roy. oct., 290 pp., 1 plate, 32 illustr....................................$5.00

Contents: Agricultural chemistry in ancient times. Agricultural chemistry in the alchemical and iatrochemical periods. Agricultural chemistry in the time of the early Royal Society. Agricultural chemistry in the early phlogiston period. Agricultural chemistry in the late phlogiston period. Agricultural chemistry during the chemical revolution. Agricultural chemistry at the beginning of the modern period.

This is one of the rare books the extraordinary scope and meaning of which have not been and apparently could not be covered adequately by title. It is far more than "A Source Book of Agricultural Chemistry." It is a documentary history of the change of chemical concepts within agriculture, and it touches in its travel from Graeco-Roman antiquity to the period initiated by JUSTUS VON LIEBIG, an almost incredible variety of subjects and ideas. Beneath the chapters forming this book and the judgments contained in it, lies an enormous amount of searching, reading, reflection and discernment. The method employed by CHARLES A. BROWNE is a bio-bibliographical one. Brief but pertinent biographies of the authors quoted are followed by extracts from their writings, and both authors and quotations are presented in relation to the world in which they lived and to posterity, offering much essential information for every one interested in the development of science and of human thought (URDANG *in* J. AM. PHARM. ASSOC.).

Perhaps few general histories of science come sufficiently close to historical grassroots to actually be in a position of demonstrating the true educational and intellectual value of science history. The volume under review accomplishes precisely that to a degree seldom equalled (GRAUBARD *in* THE SCI. MONTHLY).

► THOMAS JEFFERSON AND THE SCIENTIFIC TRENDS OF HIS TIME *by* **C. A. Browne**, Ph. D., Sc. D. (U. S. Dept. of Agriculture). — A scholarly essay, by the Nestor of American Agricultural Chemists, on THOMAS JEFFERSON'S position in the world of science, his "Notes on the State of Virginia", his scientific services to the new republic of the United States, his agricultural and educational work, and some of the eminent contemporaries who knew JEFFERSON personally and exchanged with him

letters that throw much light on the scientific movements of the time. — *Chronica Botanica, Vol. 8, No. 3 (1944)*; Sup. roy. oct., 64 pp., illustrated with 17 contemporary drawings, maps, and facsimiles......$1.25

This volume is one of the finest tributes to THOMAS JEFFERSON which has recently been published to commemorate the 200th anniversary of his birth. It is handsomely illustrated with maps, facsimiles, a wood cut of Monticello, an old wood engraving of the University of Virginia, a diagram of the Monticello Garden, a silhouette of JEFFERSON, a drawing of the plant *Jeffersonia* Barton, and other cuts . . . This timely, scholarly, carefully documented, and beautifully written account of the labors of JEFFERSON and his contemporaries is a valuable contribution to the history of science in America (WEEKS *in* J. OF CHEM. EDUC.).

► **THE CEREAL RUSTS AS EXEMPLIFIED BY THE LEAF RUST OF WHEAT** *by* **K. Starr Chester**, Ph.D. (Oklahoma Agricultural and Mech. College). — Wheat is the world's foremost crop and rust its most formidable adversary. The book provides a pattern of the principal features of cereal rust behavior and control based on a comprehensive account of the most widespread and in many cases the most destructive of the cereal rusts, the leaf rust of wheat, which has not hitherto been the subject of monographic treatment. The exposition, which has an international point of view, is based on the world literature, particularly the Russian, and on the author's researches in the field. Especial emphasis is given to environmental relationships and epiphytology of the rust. — *Ann. Crypt. et Phytop., Vol. 4;* Sup. roy. oct., buckram, ca. 250 pp., illustrated, *in press, ready summer 1946*...................... *ca.* $5.00

Contents: Introduction; names and history of the disease. Origin, distribution, and economic importance. Effect of the rust on the host plant and its yields. Suscepts. Symptomatology. Etiology. Physiologic specialization. Factors affecting rust survival and development. Rust dissemination; annual cycles; epiphytotics. Natural, regulatory, and cultural rust control. Rust control by the use of fungicides. Control by rust resistance.

► **ARBORETUMS, THEIR AIMS AND SCOPE** *by* **Gordon D. Cooper**, B.S.A., Fellow, Am. Soc. of Landscape Architects (Cleveland, O.). — The author, who has gone to great efforts to study the organization and growth of arboretums in the U.S.A., presents a detailed analysis of all possible problems connected with the establishment and development of an arboretum, with special reference to North American conditions. There are two interesting supplements: (1) a historical account of arboretums, on an international basis, by L. H. BAAS BECKING, and (2) an annotated list of the principal arboretums of North America. — *Chronica Botanica, Vol. 11, No. 3;* Sup. roy. oct., ca. 100 pp., illustrated, *in press, ready spring 1947*..$3.00

Contents: Botanical institutions. Purposes of arboretums. Need for arboretums. History of arboretums. Functions of arboretums. Requirements for a modern arboretum. Selection of sites for arboretums. Contents of arboretums. General design of arboretums. Special design. Steps in the making of an arboretum. Supplements (*cf. supra*).

► **GENERA FILICUM — THE GENERA OF FERNS** *by* **Edwin Bingham Copeland**, Ph. D. (Univ. of California). — An account of the genera and families of pteridophytes filling the long-felt need for a modern account of the ferns and fern allies of the world. — *Ann. Crypt. et Phytop., Vol. 5;* Sup. roy. oct., buckram, ca. 300 pp., 10 plates, *in press, ready autumn 1946*..................................$6.00

From the foreword: The first reason for the preparation and publication of this book is the fact that progress in our understanding of systematic pteridology during the past half-century has been so great that no existing general work on the subject retains much more than a historical value. — The second is that it beseems the author of a large number of papers dealing with details and with parts of a general subject to digest and summarize his work, and to present it properly integrated with that of his predecessors and contemporaries . . . This may be something of wider significance than a treatise on the genera of ferns. It is the author's belief that pteridology has returned to its position of a century ago, as the best developed field of systematic botany; that it is possible to demonstrate the phylogeny of fern genera more clearly and convincingly than that of any other similarly great group of plants can be presented.

► **PEAT — THE FORMATION, COMPOSITION, PROPERTIES AND UTILIZATION OF THE PEATS OF THE WORLD,** *by* **A. P. Dachnowski Stokes**, Ph.D. (U.S. Dept. of Agriculture). — The author's own research and experience of many years give him the background necessary to a better understanding of peat deposits throughout the world, their materials, and the factors affecting their utilization. The book summarizes basic information and shows how the progress in peat investigations has led to specialization of research in various lines of scientific study. The more important results so far achieved by government agencies, experiment stations, universities, and other research institutions are discussed, together with their wide implication to agriculture, industry, and technology. — *A New Series of Pl. Sci. Bks., Vol. 20;* Roy. oct., buckram, ca. 220 pp., illustrated, *in press*............ *ca.* $4.50

Contents: Introduction. Main groups and types of peat, their botanical composition and uses. Physical properties of different kinds of peat. Chemical composition of various peat materials. Thermochemistry of peats. Microbiological activity in the formation and decomposition of peat materials. Biochemical activity in peat composts. Formation and stratification of peat deposits. Factors in the classification of peat deposits. Geographical distribution of peat deposits. Correlations. Bibliography.

► **PRINCIPLES OF PALEOBOTANY** *by* **William C. Darrah** (Harvard U.).—*A New Series of Pl. Sci. Bks., Vol. 3 (1939)*; Roy. oct., 239 pp., 7 pl.; *out of print,* a new edition is in preparation.

► **AN INTRODUCTION TO POLLEN ANALYSIS** *by* **G. Erdtman**, Fil. Dr. (Västerås, Sweden). *Foreword by* **Roger P. Wodehouse**, author of 'Pollen Grains'. — The first and only comprehensive reference work on the methodology and applications of pollen analysis. — *A New Series of Pl. Sci. Bks., Vol. 12 (1943)*; Sup. roy. oct., buckram, 239 pp., 46 plates and illustr. $5.00

From the contents: Historical. Chemistry of Peat. Pollen Preparations. Preparation of Fossil Pollen-Bearing Material. Pollen and Spore Morphology. Graphic Presentation. Correlation. Output and Dissemination of Pollen. Surface Samples. Pollen Flora of Peat Samples. Investigations in different Countries. Tertiary Deposits. Honey and Drugs.

It was G. ERDTMAN, a Swede, who in the nineteen-twenties introduced British and American scientific men to the principles and technique of pollen analysis, a new method of geological inquiry which had recently been developed in Scandinavia, particularly by the energy and insight of L. VON POST. The succeeding years have seen a very great extension of the applications of pollen analysis. Not only has it been used in countries in all parts of the world to elucidate their forest history, and thence the drift of former climatic conditions, but also it has been shown to afford the means of solving an unexpectedly wide range of problems . . . It has long been recognized that dating of prehistoric objects and structures found in lake or bog deposits is often possible by reference to the geochronological scale afforded by the regular drift of forest history. Similarly, the course of relative movement of land- and sea-level may be effectively dated, and eustatic effects distinguished from isostatic. More recently, it has become apparent that not only is the former distribution of natural plant communities reflected by pollen analyses, so that the conditions of salt-marsh, lake, fen, forest and bog may be accurately recognized in buried layers, but also, as IVERSON has shown, the influence of prehistoric man in modifying natural communities may be detected, together with the origin of the new anthropogenous vegetation he has created . . . Hitherto no text-book of pollen analysis has

been available, and we warmly welcome, therefore, the appearance of the "Introduction to Pollen Analysis" by Dr. ERDTMAN. He has himself in the last twenty years contributed important results to the field of pollen analysis. He has developed a technique of preparation by chlorination and acid-hydrolysis which very greatly simplifies counting of grains in materials poor in pollen: he has sharpened the technique of critical recognition of species by their pollen morphology, and he has contributed much to the knowledge of long-distance flight of pollen. In this book these matters are given adequate treatment, together with such related topics as the analysis of pollen in honey as a basis for determination of the country and season of its origin, and the geological use of spore-counts in coal seams (GOODWIN *in* NATURE).

▶ **THE GENUS BAZZANIA IN CENTRAL AND SOUTH AMERICA** *by* **Margaret Fulford**, Ph.D. (Univ. of Cincinnati). — A critical monograph of one of the most interesting genera of liverworts, the first complete modern revision of the neotropical species of a large and difficult genus of hepaticae, since STEPHANI produced his confusing *Species Hepaticarum*. — *Ann. Crypt. et Phytop., Vol. 3;* Sup. roy. oct., ca. 176 pp., 59 plates, *in press, ready shortly*.......**$5.00**

▶ **ROOT DISEASE FUNGI** *by* **S. D. Garrett**, M.A., D.I. (Rothamsted Experimental Station). — The first book dealing exclusively with this important group of fungi. Principles of root disease control are fully expounded for the benefit of all practising plant pathologists. Control measures are classified separately for field, plantation and glasshouse crops. A special feature is the full treatment of root disease control in tropical and subtropical crops, but no important root disease of any crop has been omitted. Of particular interest to soil microbiologists are the chapters on biology and evolution of the root-infecting fungi. — *Ann. Crypt. et Phyt., Vol. 1 (1944)*; Roy. oct., buckram, 177 pp., 9 illustr...**$4.50**

Contents: Parasitic specialisation in the root-infecting fungi. Parasitic activity of the root-infecting fungi. Influence of soil temperature upon parasitic activity. Influence of soil moisture content, texture, and reaction upon parasitic activity. Influence of soil organic content and concentration of plant nutrients upon parasitic activity. Saprophytic activity of the root-infecting fungi. Dormancy of the root-infecting fungi. Control of root disease in field crops: crop rotation. Control of root disease in field crops: plant sanitation. Control of root disease in field crops: disease control under the growing crop. Control of root disease in plantation crops: on virgin areas. Control of root disease in plantation crops: in mature plantations and on replanted areas. Control of root disease in plantation crops: special problems. Control of root disease in glasshouse crops. Bibliography.

The appearance of this book marks the first volume of Annales Cryptogamici et Phytopathologici, edited by FRANS VERDOORN. The author stresses the relationships between the inciting agents of these diseases and their habitats—the soil. The book is an interesting ecological study of an important group of causal agents within the larger field of root diseases of plants . . . It is well written and the illustrations are excellent (LINK *in* THE BOT. GAZETTE).

This book is of more than usual interest to those having to do with soil management in relation to crop production in that it deals with one of the more obscure phases of this problem about which there is great need for more exact information than has been contained in the usual classroom textbook (SOIL SCIENCE).

A copy of Garrett's Root Disease Fungi was included in the highly selective exhibit, organized in San Francisco at the occasion of the United Nations Conference, of 120 technically outstanding books, recently produced in the U. S. A.

▶ **WOOD PULP** *by* **Julius Grant**, Author of 'Books and Documents', etc.—*A New Series of Pl. Sci. Bks., Vol. 2 (1938)*; Roy. oct., 209 pp.; *out of print*.—It is planned to deal again with the subject matter of this book in a forthcoming volume on wood chemistry and related subjects.

▶ **THE CYTOPLASM OF THE PLANT CELL** *by* Dr. **Alexandre Guilliermond** (Sorbonne), *authorized translation from the unpublished manuscript by* **Lenette Rogers Atkinson.** *Foreword by* **William Seifriz.** — A critical review of our present knowledge of the cytoplasm and its morphological constituents by the eminent French cytologist. — *A New Series of Pl. Sci. Bks., Vol. 6 (1941)*; Sup. roy. oct., buckram, 247 pp., 152 illustr............................**$4.75**

Contents: General facts on the structure of the plant cell, its cytoplasm and morphological constituents. The physical properties and general characteristics of the cytoplasm. Chemical constituents. Physico-chemical constituents of the cytoplasm. The plastids. The chondriome. The relationship between chondriosomes and plastids. Duality of the chondriome. Hypotheses relative to the role of chondriosomes and plastids. The vacuoles. Vital staining of the vacuoles. Development of the vacuolar system. Origin and significance of the vacuoles. The role of the vacuolar system and hypotheses concerning it. Golgi apparatus, canaliculi of Holmgren and other cytoplasmic formations. Lipide granules, microsomes and other metabolic products. Cytoplasmic alterations.

The present volume is the first addition, printed in America, to the list of books which Dr. FRANS VERDOORN is editing and publishing under the title, A New Series of Plant Science Books. Mrs. ATKINSON has accomplished an excellent job of translating and interpreting for English readers a highly stimulating work, which can be recommended to botanists generally (BEAL *in* BOT. GAZETTE).

This book gives a thorough, critical and well-balanced survey of the various theories on cytoplasm, chondriosomes, plastids, vacuoles, etc., in which both the morphological and the functional (physico-chemical) point of view have been adequately stressed. Though the author, as one of the leading cytologists, has his own pronounced views, he always does justice to contrary views, so that a very high degree of objectivity in the treatment is obtained (LÜTJEHARMS *in* J. S. AF. BOT.).

▶ **LECTURES ON THE INORGANIC NUTRITION OF PLANTS** *by* **D. R. Hoagland**, A.M. (Univ. of California). — This series of lectures, based on the *Prather Lectures at Harvard University,* delivered by the author in the spring of 1942, outlines a number of important problems of plant nutrition, with a very considerable amount of illustrative material derived from extensive researches at the Univ. of California. Scientific aspects of certain soil-plant interrelations, nutrient absorption and utilization, and artificial culture methods are primarily discussed. Trends of research in plant nutrition and opportunities for further exploration are stressed. — *A New Series of Pl. Sci. Bks., Vol. 14 (1944)*; Roy. oct., buckram, 226 pp., numerous ill., tables and plates............**$4.00**

Contents: A survey of problems. Micronutrient chemical elements and plant growth. The absorption and accumulation of salts. Upward movement and distribution of inorganic solutes. The growth of plants in artificial media. Some biochemical problems associated with salt absorption. Aspects of the potassium nutrition of plants as illustrating problems of the system, soil-plant-atmosphere.

The discussions are based upon work done in many laboratories, but with emphasis upon work done in the Div. of Plant Nutrition of the Univ. of California, where Dr. HOAGLAND's genius has found its expression in a long series of distinguished contributions. He and his coworkers have been leaders in this field for many years, and it is a valuable service to plant physiologists to have the field presented by one so familiar with the techniques and the historical development of the subject of inorganic nutrition of plants. It is excellent in bringing the various phases of nutrition into a true perspective, and giving in compact space the essential ideas and philosophy of this region of plant physiology.—It is so well done that it is hoped that every member of *the American Society of Plant Physiology* will want a personal copy of it (PLANT PHYSIOLOGY).

Aunque el Prof. HOAGLAND, primera autoridad sobre estos estudios en el Continente americano, no considera esta compilación de conferencias, ni como monografía ni como libro de texto, estimamos que es la mejor exposición actual, en lengua inglesa, sobre nutrición mineral de los vegetales, principalmente de los superiores, libro indispensable para el fisiólogo y también para el agrónomo que se interese por la fertilización de los suelos y el alimento de las plantas de cultivo (M. CASTAÑEDA *in* CIENCIA).

▶ **SCIENCE AND SCIENTISTS IN THE NETHERLANDS INDIES** *edited by* **Pieter Honig**, Ph. D. and **Frans Verdoorn**, Ph. D. — A review of research

and exploration in the Neth. Indies. Prepared under the auspices of the Board for the Netherlands Indies, Surinam and Curaçao. — *Natuurwet. Tijdschrift voor Ned.-Indië, Vol. 102, Special Supplement (1945)*; Sup. roy. oct., cloth, xxiv + 491 double column pp., 134 pl. and text illustr............$4.00

From the contents: *Bakker:* On livestock and the veterinary service; *van Bemmelen:* Mineral resources and their industrial possibilities; *Bernard:* Le Jardin Botanique de Buitenzorg; *Braak:* The climate and meteorological research; ter *Braake:* Volcanology in the Netherlands Indies; *Brest van Kempen:* Earthquakes in the Netherlands Indies; *Broek:* Diversity and unity in Southeast Asia; *Coombs:* The International Rubber Regulation Committee; *Coster:* The West Java Research Institute; *Dammerman:* A history of the Treub laboratory; *Donath & van Veen:* A short history of beri-beri investigations; *Fairchild:* Buitenzorg and Doctor Treub (1896); *Fairchild:* Rambles in Deli (1926); *Fairchild:* Gardens of the East from the air (1940); *Field:* Felix Alexander Vening Meinesz; *Forbes:* Through Bantam and the Preanger Regencies; *Frickers, Haasjes & Hoskins:* On veterinary science; *Groot:* Missionary physicians and hospitals; *von Heine-Geldern:* Prehistoric research in the Netherlands Indies; *Herre:* Fish research in the Indo-Australian archipelago; *Honig:* Agriculture in the Netherlands Indies; *Honig:* Cinchona—introductory review; *van Gorkom:* Introduction of cinchona into Java; *van Leersum:* Junghuhn and cinchona cultivation; *van Gorkom:* Cinchona cultivation after Junghuhn; *Taylor:* Modern developments in cinchona cultivation; *Koolhaas:* Half a century of phytochemical research; *Koolhaas:* Phytochemical researches by visitors; *van de Koppel:* Forestry in the outer provinces; *Kuiper:* Astronomy in the Netherlands Indies; *Lieftinck & van Bemmel:* The Buitenzorg Zoological Museum; *Massart:* Notes javanaises; *Mayr:* Wallace's line and recent zoogeography; *Mohr:* Climate and soil; *Mohr:* Soil and population density; *Moon:* On Pinus mercusi of N. Sumatra; *Myers:* Sediments in the Java Sea; *Otten-van Stockum:* Rabies research in the Neth. Indies; *Posthumus:* Paleobotanical research in the Neth. Indies; *Riemens:* The Hot Springs Conference; *Roelofsen:* The Deli Tobacco Experiment Station; *Schneider:* Eine Reise in Nord-Sumatra; *Sirks:* Rumphius, the Blind Seer of Amboina; *Snapper:* Medical contributions from the Neth. Indies; *Stauffer:* The geology of the Netherlands Indies; *van Steenis:* A trip to South Sumatra; *Tengwall:* Rubber cultivation and research; *Vlugter:* Hydrodynamic research in the Netherlands Indies; *de Waart:* Medical education in the Netherlands Indies; *Wallace:* Exploration in Celebes; *Weidenreich:* The puzzle of Pithecanthropus; *Went p. & f.:* General botany in the Neth. Indies; *Dammerman:* The fauna of Tjibodas; *Doctors van Leeuwen:* The flora of Tjibodas; *Dakkus:* The Botanical Garden at Tjibodas; *Westermann:* Wild life conservation in the Netherlands Empire.

The volume concludes with an extensive list of research institutions and research workers in science and technology in the Netherlands Indies at the time of the 1942 invasion, news items, bibliographical notes, a report of the Central Depository Library for the Netherlands Indies in New York City (established by VERDOORN in 1943), etc.

► **FUNGICIDES AND THEIR ACTION** *by* **J. G. Horsfall**, Ph.D. (Connecticut Agric. Experiment Station). — An examination of the physics and chemistry of the mechanisms by which fungicides control plant diseases. Pertinent data are reviewed and critically discussed in the light of a relatively new tool for assay; namely, dosage-response. An analysis is given of the problem of deposition, coverage and tenacity as factors in protection. A discussion is also given of the factors in artificial immunization and chemotherapy, synergism, and modes of toxic action, for copper and sulphur, fungicides. The book ends with two chapters on the new organic fungicides and phytotoxicity. — *Ann. Crypt. et Phyt., Vol. 2 (1945)*; Roy. oct., buckram, 239 pp., 19 illustr.........$5.00

Contents: Historical introduction. Some general concepts. Laboratory assay. Some problems of data assessment. Principles of chemical protection. Deposition. Coverage of single surfaces. Coverage of multiple surfaces. Tenacity. Artificial immunization and chemotherapy. Action of copper. Action of sulfur. Action of organic nitrogen compounds. Action of other organic compounds. Antagonism and synergism. Phytotoxicity.

►**LUTHER BURBANK, A VICTIM OF HERO WORSHIP** *by* **W. L. Howard**, Ph. D. (Univ. of California). — Some twelve years ago the writer undertook the preparation of an authentic list of all fruits, flowers, vegetables, and other things, the late LUTHER BURBANK introduced during the fifty years of his working life, and where possible, giving some idea of their worth. The task was prolonged because BURBANK kept no systematic record of what he produced. His advertising literature was scattered to the four winds. The author personally examined libraries and private collections from Coast to Coast. To determine the value of many of BURBANK's productions it was necessary to contact dealers all over the world. — A by-product of the studies was a mass of information, much of it new, about the man himself, which answered many puzzling questions. — *Chronica Botanica, Vol. 9, No. 5/6 (1945)*; Sup. roy. oct., 208 pp., illustrated by photographs and facsimiles.......$3.75

Contents: The background. The man. The nurseryman. The scientist. The egoist. The mentor of youth. The unfortunate. The pariah (of scientists). The disappointed. The world character. The individualist. Ethics. Religion. Foray into science—the Carnegie grant. Admirers. Detractors. BURBANK's place in the hall of fame. Summary of BURBANK's productions. Aftermath. The BURBANK family.

In 21 chapters the leading events of BURBANK's life are discussed objectively, but fairly, frankly and without embellishment. This is, without doubt, the first true and complete picture of this controversial character, which labored for 50 years to improve economic plants and which produced and sent out over 800 new varieties of fruits, flowers and vegetables, many of them of permanent value.

► **BIOLOGICAL FIELD STATIONS OF THE WORLD** *by* **Homer A. Jack**, Ph. D. — An extensive and critical study of the aims, scope and organization of the biological field stations of the world. A unique

---

► A few technical notes: — If we feel that there is some chance that we will break even we issue our publications bound in buckram, stamped with genuine gold (this is hardly ever used at present, not even by the university presses), with fine endpapers such as are only used in limited editions, etc.—When the number of advance orders is so small that we feel sure that a publication will be published at a positive deficit, it is our policy to issue it strongly bound in paper. This is the only 'sacrifice in quality' which we sometimes make. In all other aspects our publications, those which are commercially sound, as well as those which are published at a loss, are produced according to unusually high and internationally famous standards, printed on superior, durable paper. Though this is no longer usual in much commercial work we continue to print all personal names with SMALL CAPITALS, and Latin plant names with *italics*.

* * * *

The Publishers' Weekly discussing "Hayfever Plants", a typical, average volume of our "A New Series of Plant Science Books", declares: [This] "is an excellent example of how, with good typographical knowledge and great skill, a scholarly text embodying such difficult features as tables, figure columns, footnotes, glossary, and bibliography, can be made into a handsome almost elegant book. Verdoorn successfully solved many knotty problems in the design of this volume, and it is unfortunate that space will not allow a more detailed discussion of the points involved. The many line cuts of plants beautifully combined with the text have produced a perfectly balanced page. The type pages, though at times by necessity quite condensed, are always clean and readable. Chapter titles and section titles contrast well with the old style used for the text. Nothing has been left undone to increase the consultability of the material and yet no space has been wasted. The end paper in French blue nicely matches the dark blue buckram of the binding, the Bordeaux red top stain and head band add to the appearance of this handsome volume."

account of great practical, as well as historical interest. Based on the results of years of travel and world wide systematic enquiries. — *Chronica Botanica, Vol. 9, No. 1 (1945)*; Sup. roy. oct., 74 pp., illustrated $2.50

From the contents: Purpose of biological stations. History. Location. Administration. Equipment. Living Facilities. Instruction. Educational Philosophy. Research. Annotated list of biological stations covering the entire world, with much practical information, publications, references, etc.

► PLANT EMBRYOLOGY, AN INTRODUCTION TO THE EMBRYOLOGY OF THE FLOWERING PLANTS *by* Donald A. Johansen, Ph. D., author of 'Plant Microtechnique'. — This is the first book to be prepared that deals exclusively with embryology sensu stricto. The gymnospermous phyla are first discussed, following which the flowering plants are exhaustively considered. The laws of embryogeny are described in detail and illustrative examples are cited. These laws form the basis for a simple, logical classification of the various types of embryogeny prevalent among angiosperms. A systematic treatment of all species whose development has been sufficiently described in the literature is presented, with each species classified as accurately as possible. Apomictic embryogeny, adventitious embryogeny and polyembryony are considered in separate chapters and the various manifestations of each have also been classified. — *A New Series of Pl. Sci. Bks., Vol. 19;* Sup. roy. oct., buckram, ca. 300 pp., with numerous illustrations, *in press, ready shortly* .... *ca.* $6.00

Contents: Cycadophyta: Cycadaceae. Ginkgophyta: Ginkgoaceae. Coniferophyta: Pinaceae, Araucariaceae, Sciadopitaceae, Taxodiaceae, Cupressaceae, Saxegothaeaceae, Podocarpaceae, Pherosphaeraceae, Cephalotaxaceae, Taxaceae. Ephedrophyta: Ephedraceae, Gnetaceae, Welwitschiaceae. Anthophyta: General Considerations, Types and Variations, Special and Comparative Embryology, Apomictic Embryogeny, Adventitious Embryogeny, Polyembryony. Glossary, Indices.

► THE CARNIVOROUS PLANTS *by* F. E. Lloyd, D. Sc., Emeritus Prof. of Botany, McGill University.—Since the appearance of CHARLES DARWIN'S "Insectivorous Plants" in 1875 no comprehensive treatise on these biologically exceedingly interesting plants has appeared. The gradual advance of our knowledge has been summarized from time to time by DRUDE, PFEFFER, ED. MORREN, HOOKER, GOEBEL and LLOYD, but a fully documented treatment was greatly needed. The illustrations are nearly all original and include numerous halftone plates, enabling the reader to visualize the forms discussed, and a large number of line drawings amplifying the text. — *A New Series of Pl. Sci. Bks., Vol. 9 (1942)*; Sup. roy. oct., buckram, 352 pp., several hundred illustrations $6.00

Contents: Introduction. Heliamphora. Sarracenia. Darlingtonia californica. Nepenthes. Cephalotus follicularis. Genlisea. Byblis. Drosophyllum lusitanicum. Pinguicula. Drosera. The carnivorous Fungi. Dionaea. Aldrovanda. Utricularia, Biovularia, and Polypompholyx. Indices.

It is so clearly and entertainingly written that anyone with a modicum of botanical knowledge can enjoy it and use it as a guide. Professor LLOYD'S drawings and photographs are very clear and helpful, and the 38 plates incorporate hundreds of them. Production is of the high standard we have learnt to expect from Chronica Botanica. Altogether, a distinguished performance for which thanks and congratulations are due to both author and publisher (STEPHENS *in* J. So. AF. BOT.).

It is, therefore, the more commendable and welcome that finally LLOYD has completed this comprehensive authoritative, and detailed study of the carnivorous plants. Any such study which traces a function or an activity through the diverse plants possessing it is bound to have a significant influence on science, and this authoritative volume without doubt will prove to be an epoch-making one. Comprising in large part the author's own original work, yet with a masterly synthesis of all the pertinent work previously done by others, the book has a thoroughness and completeness that stamp it as outstanding. All possible aspects of the plants concerned—their taxonomy, anatomy, physiology, ecology, and relationship—are considered in detail, with authoritative knowledge derived from the writer's 13 years of enthusiastic devotion to this field, devotion that involved careful absorption of an extensive literature in several languages, and first hand study of living material on this continent, in Europe, and in more remote localities during two journeys—one to Africa, another to Africa and Australia—supplemented by extensive correspondence, by securing the cooperation of collectors and naturalists in favorable localities, and by periods of study at various botanic gardens and laboratories . . . The volume is a beautiful job of craftsmanship (QUART. REVIEW OF BIOL.).

► TREE GROWTH *by* D. T. MacDougal (Carnegie Inst. of Washington).—*A New Series of Pl. Sci. Bks., Vol. 1 (1938)*; Roy. oct., 240 pp., 20 illustrations; *out of print.*—Some time in the future we hope to publish a revised ed. or to include a treatment of the essentials of tree growth in a book on tree physiology. A few copies may still become available when we can again get in touch with our continental agents.

► EXPERIMENTELLE CYTOLOGIE *von* Hans H. Pfeiffer (Bremen).—The first comprehensive review by an internationally known and appreciated authority.—*A New Series of Pl. Sci. Bks., Vol. 4 (1940)*; Roy. oct., 243 pp., 28 illustr.; *out of print.*—A few copies may again become available as soon as we will be able to get in touch with our agents in the Netherlands. A second revised and enlarged edition will be published some years after the war.

► A LIFE OF TRAVELS *by* C. S. Rafinesque (1836). — A complete and verbatim reprint of the extremely rare autobiography (1836) of this famous and eccentric naturalist. FITZPATRICK (1911) lists only 17 known copies in the libraries of the world. — *Chronica Botanica, Vol. 8, No. 2 (1944)*; Sup. roy. oct., 72 pp., 5 portraits......................$2.50

Contents: Life and Travels till the first departure for America. Travels in North America during three years. Ten years' residence and travels in Sicily. My shipwreck and travels till 1819. Seven years' residence and travels in Kentucky. Travels from 1825 to 1830, in Virginia, Ohio, New York, etc. Travels and researches 1831/33. The sources of the R. Delaware and Susquehana. Conclusion. Travels and researches in 1834 and 1835, sources of the Schuylkill, central Alleghanies of Pennsylvania, Savings Banks, etc.

Only during the last 60 years has it dawned upon Americans, that the strange man, who died poor and lonely in Philadelphia in 1840 after having lived for 27 years among them, was not the "inspired idiot" he had been thought of and treated accordingly, but one of the greatest glories of

early American science, especially in the field of botany, zoology and anthropology. It seems he was even a great innovator in business, in inventing the "coupon" system in commercial papers. In his own case at least RAFINESQUE's hopeful statement, "But time renders justice to all at last" seems to come true. This reprint of RAFINESQUE's autobiographical sketch, still the fundamental document for all biographical work on the man, is a most welcome expression of the steadily increasing interest in RAFINESQUE. In spite of displaying an overwhelming amount of travelling done and of interests developed by RAFINESQUE, this self-description is still rather an understatement of the actual truth. The same is true of the almost unbelievable amount of ill luck and bad treatment experienced by the "eccentric naturalist." This autobiography, in listing carefully the scientific contacts of RAFINESQUE, which are identified by Dr. F. W. PENNELL and the VERDOORNS in an excellent index, gives a lively picture of American science in the first half of the 19th century,—and of the state of things in Sicily between 1805 and 1815 where RAFINESQUE was confined during the blockade. As CONSTANTINE SAMUEL RAFINESQUE-SCHMALTZ was born in 1783 in Constantinople the son of a French merchant and Greek lady of German ancestry, and as he was educated in France and Italy, allusions to other countries than the United States and Sicily, the two countries he studied longest and most intensely, are not lacking (ACKERKNECHT *in* BULL. HIST. MED.).

► A SHORT HISTORY OF THE PLANT SCIENCES *by* H. S. Reed, Ph.D. (U. of California). — A readable account of the growth of the plant sciences from early times to the present. The first 'History of Botany' written by an American and published in the U.S.A. — *A New Series of Pl. Sci. Bks., Vol. 7 (1942)*; Sup. roy. oct., buckram, 323 pp., 37 illustr. $5.00

Contents: Introduction. Gardeners and herbalists of antiquity. The nascent period. The retrogressive period. The renascent period. The seventeenth century. The eighteenth century. Gardens and other things. Plant geography in the nineteenth century. Morphology. Cytology. The water economy of plants. The fixation of carbon. The assimilation of nitrogen. The fixation and metabolism of nitrogen. Plant nutrition. Mineral constitutents in metabolism. History of mycology. Plant pathology. Significant names in the history of botany.

REED's "Short History" is more than a dry record of progress. Through the kind and appreciative eyes of one of America's best-liked botanists the kaleidoscopic change in scenes and actors on the stage of botanical progress becomes a vivid adventure. This book will be enjoyed not only by professional botanists but also by students and others . . . This book is thoroughly original, in scope and treatment as well as in illustrations. We do not find the traditional portraits of the paragons of science which often are of questionable authenticity and usually are entirely non-committal as to the character of the subject. Instead, original illustrations of significant experiments, laboratories or publications are depicted, with delightful originality. One of the special values of the book is the adequate, though not undue, stress laid on the contributions of American scientists. The reviewer was surprised to find how seldom he disagreed with the author, which can only be attributed to the care with which Dr. REED has considered each contribution and the sympathy with which he has treated each contributor. It is easier to criticize mistakes than to appreciate positive advances, which become incorporated in our general body of knowledge and which can be recognized as advances only after careful consideration (WENT *in* SCIENCE).

► ESQUISSE DE MES VOYAGES AU BRÉSIL ET PARAGUAY, CONSIDÉRÉS PRINCIPALEMENT SOUS LE RAPPORT DE LA BOTANIQUE *par* **Auguste de Saint-Hilaire,** *with a biographical sketch by* **Anna E. Jenkins**, Ph. D. — *Chronica Botanica, Vol. 10, No. 1;* Sup. roy. oct., ca. 70 pp., illustrated, *in press, ready shortly*.......$2.00

This extensive travel account, reprinted from SAINT-HILAIRE's *Histoire des Plantes les plus remarquables du Brésil et du Paraguay,* is being reprinted primarily at the request of a number of S. American botanists. Though in the first place of interest to botanists (the author gives an accurate description of his route) it contains much of a general biological, geographical and historical interest.

► PLANTS AND VITAMINS *by* Dr. W. H. Schopfer (Univ. of Berne), *authorized translation from the author's unpublished French-Swiss manuscript by* **Norbert L. Noecker** (U. of Notre Dame). *Foreword by* **W. J. Robbins.** — A critical review of the vitamin problem, written from the viewpoint of general physiology, transecting the various fields of biology; microbiology, plant and animal physiology, biochemistry, morphology, cytology, genetics, medicine, plant pathology, horticulture, and agriculture. The practical applications of vitamin research are given special consideration. The theoretical aspects are also treated and should be of interest to students and teachers of general biology. — *A New Series of Pl. Sci. Bks., Vol. 11 (1943)*; Sup. roy. oct., buckram, 300 pp., 20 illustr. $4.75

Contents: The plant cell and its capacity for synthesis. The experimental study of growth factors and the selection of test plants. Classification, terminology, and definition of active substances. The principal vitamins synthesized by plants. Their action on plants synthesizing them. The biosynthesis of vitamins. Thiamin. Yeast and bios. Nicotinic acid, its amide, and other analogues. Staphylococcus aureus. Riboflavin, pyridoxine, and their analogues. The lactic bacteria. The nitrogen fixing bacteria. The hemophilic organisms and their group of growth factors. Individual factors: Ascorbic acid, cholesterol and vitamin D, pimelic acid, the SH-Group. The function of growth factors of vitamin nature. The vitamins as coenzymes. The vitamins in relation with other active substances. General consideration concerning the presence and the loss of the capacity for synthesis. Vitamins in nature. Their rôle in agronomy and horticulture. Vitamin cycles. Growth factors and sexuality. Symbiosis, parasitism, and vitamins. Microorganisms as biological test objects for vitamins.

It is that rare thing: a complete textbook. Apparently everything relevant has been included, and the matter is right up to date as far as it is possible for it to be. 'Plants and Vitamins' gives the conspectus of a new subject—the need of plants for vitamins (NICOL *in* SOILS AND FERTILIZERS).

Few studies in biochemistry have aroused such popular interest as the remarkable advances made in recent years concerning the dependence of animals on small doses of those substances, produced mainly by plants, which we call the vitamins. It is natural that the marked heterotrophy for these substances in man has stimulated interest largely in the vitamin aspects of animal nutrition; but it has always seemed anomalous that the importance of vitamins to the plant which makes them, realized only vaguely even by many botanists, has not had wider publication. This gap has now been filled in this remarkable book, and it is well that the first major review should come from the hands of an expert, and indeed one who may be said to be the founder of the modern science of plant vitaminology. His book is, as it must be, of the nature of a preliminary report on a subject now in the full tide of development; but it tells, in an orderly way, of all the important advances made in the ten years since SCHOPFER (1934) first showed the necessity for vitamins in the culture of *Phycomyces,* with sufficient bibliography to enable enthusiasts to find other sources of information. It is further very satisfactory that the author, though not hesitating to reproduce and discuss the structural formulae of the vitamins and to emphasize the vitally important, if purely chemical aspects of vitamin structure, does not fall into the trap of making the work biochemical. It is a book written by a plant physiologist for plant physiologists (PRESTON *in* NATURE).

► PLANTS AND PLANT SCIENCE IN LATIN AMERICA, *edited by* **Frans Verdoorn**, Ph. D. — For a number of reasons the Editors of CHRONICA BOTANICA felt that an account concerning the vegetation and natural resources, as well as the present status and future of various branches of the plant sciences in Latin America, would be the most appropriate contribution they could make at present to the improvement of international relations and coöperation in the plant sciences, a field which presents in Latin America many problems of a great, often truly international, importance. — The aim of this collection of nearly a hundred accounts of the vegetation and plant resources (with information on agriculture, forestry, phytopathology, etc.) of the countries of C. and S. America is to give the agronomist, botanist, forester and phytopathologist, wherever he may be located, information which he may need when starting work on the wild or cultivated plants of Latin

America. It is hoped that it may be still more useful for those who plan to go to Latin America to collect or to conduct research. The collection endeavours to give some information concerning the present status of and the future possibilities and needs for research in the chief branches of the pure and applied plant sciences in Latin America. In addition to data in his own field, the specialist will find much useful and stimulating information on vegetational and agronomic problems in general, on the organization of research, lists of books that he may consult, addresses of institutions and societies in the territory in which he is interested and which he may profitably contact, etc. — Special features are the plates, often reproduced from classical publications, and the extensive introductory chapters by POPENOE (Problems of Tropical American Agriculture), JOHNSTON and SMITH (Vegetation Types), FOSBERG (Economic Botany), and PENNELL (History). There is also a special supplement by KRUG who reports in detail on plant breeding in C. and S. America. — A minor part of this volume has previously been published in CHRONICA BOTANICA and is now again presented after careful revision. Much more than half consists of original contributions, not published before, by outstanding international authorities. — *A New Series of Pl. Sci. Bks., Vol. 16 (1945)*; Sup. roy. oct., buckram, xl + 384 double column pp., 83 pl. and text illustr. **$6.00**

From the contents: Introductory Essay ('The Plant Scientist in the World's Turmoils') by the Editor (with three extensive bibliographies, including a list of Latin American travel books of a plant science interest); *Popenoe:* Some problems of tropical American agriculture; *Smith & Johnston:* A phytogeographic sketch of Latin America; *Fosberg:* Principal economic plants of tropical America; *Pennell:* Historical sketch; *Patiño Navarrete:* La agricultura y los recursos vegetales de México; *Stakman & Harrar:* Plant pathology in Mexico; *Yuncker:* The vegetation of Honduras; *Kovar:* Idea general de la vegetación de El Salvador; *Lewy van Séveren:* Recursos naturales del reino vegetal de El Salvador; *Ashton:* On the plant resources and flora of Nicaragua; *Standley:* A brief survey of the vegetation of Costa Rica; *Carabia,* A brief review of the Cuban flora; *Roig y Mesa & Acuña:* Plant resources of Cuba; *Larter:* Plant resources of Jamaica; *Holdridge:* A brief sketch of the flora of Hispaniola; *Barker:* Plant resources of Hispaniola; *Holdridge:* A brief sketch of the Puerto Rican flora; *Horn:* Plant resources of Puerto Rico; *Stehlé:* Les conditions écologiques, la végétation et les ressources agricoles de l'Archipel des Petites Antilles; *Beard:* A brief review of the vegetation of Trinidad and Tobago; *Tiedjens:* Agriculture on the islands of Curaçao, Aruba and Bonaire; *Pittier & Williams:* A review of the flora of Venezuela; *Groves:* The plant resources of British Guiana; *Stahel:* The natural resources of Surinam; *Domingues:* A agricultura no Brasil; *Souza:* The Brazilian forests; *Hodge:* The plant resources of Peru; *Rojas & Carabia:* Breve reseña de la vegetación Paraguaya; *Carabia:* Productos naturales y agricultura en el Paraguay; *Parodi:* Las regiones fitogeográficas Argentinas y sus relaciones con la industria forestal; *Parodi:* La agricultura en la república Argentina; *Tortorelli:* Los bosques Argentinos y sus industrias derivadas; *Marchionatto:* Las enfermedades de las plantas cultivadas de la Argentina y sus problemas; *Rosengurtt Gurvich:* La vegetación del Uruguay; *Boerger:* Recursos vegetales del Uruguay; *Goodspeed:* Notes on the vegetation and plant resources of Chile; *Svenson:* A brief review of the Galapagos flora; *Skottsberg:* The Juan Fernandez and Desventuradas islands; *Darrah:* A geological sketch of Central America and the Antilles; *Stone:* Climatology and meteorology; *Pendleton:* Some important soils of Central America; *Bennett:* Soil conservation in Latin America; *Müller:* Plant pathology in Latin America; *Viehoever:* Food aspects in Latin America; *Bevan:* Forestry in Latin America and its future; *Hill:* Ethnobotany in Latin America; *Darrah:* Paleobotanical work in Latin America; *Rands:* Hevea rubber culture in Latin America, problems and procedures; *Brandes:* Progress in hemisphere rubber plantation development; *Uphof:* Certain minor rubber producing plants in the western hemisphere during times of emergency; *Pennock:* Notes on cinchona culture; *Guenther:* The production of essential oils in Latin America; *Markley:* Fat and oil resources of Latin America; *Robinson:* Aims, scope, and future of research on fiber plants in Latin America; *Motz:* On fruit production in South America; *Lanjouw:* On the location of botanical collections from Central and South America; *Bates:* The advantage of the tropical environment for studies on the species problem; *Ryerson:* Agricultural scholarships and inter-American relations; *Guest:* Some of the principal Latin American plant science periodicals; *Witt:* Coöperative agricultural research and extension stations in Latin America; *Crocker:* The Tropical Plant Research Foundation Inc.; *Krug:* Plant breeding, genetics and cytology in Latin America; *Ochoterena:* Outline of the geographic distribution of plants in Mexico; *Meyer:* Forestry in Mexico; *Lundell:* The vegetation and natural resources of British Honduras; *Popenoe:* Plant resources of Honduras; *Standley & Steyermark:* The vegetation of Guatemala; *Popenoe:* Plant resources of Guatemala; *Skutch:* The natural resources of Costa Rica; *Schery:* A few facts concerning the flora of Panama; *Shreve:* The vegetation of Jamaica; *Dugand:* On the vegetation and plant resources of Colombia; *Williams:* Natural resources of Venezuela; *Albert Smith:* The vegetation of the Guianas; *Lyman Smith:* The vegetation of Brazil; *Bitancourt:* Plant pathology in Brazil; *Svenson:* The vegetation of Ecuador; *Molestina O.:* Reseña agrícola del Ecuador; *Williams:* The phytogeography of Peru; *Cárdenas:* Recursos naturales del reino vegetal en Bolivia; *Skottsberg:* The Falkland islands; *Darrah:* A brief account of the geology of South America; *Hardy:* The soils of South America; *Emmons:* Medical mycology in Latin America; *Coolidge:* Notes on conservation in the Americas; *Paterson:* Grazing versus soiling in the wet tropics; *Verdoorn & Verdoorn:* Plant Science Institutions, stations, museums, gardens, societies and commissions in Central and South America.

Those who are interested both in Latin America and biology or agriculture, have long been looking for a compilation like "Plants and Plant Science in Latin America."—It will prove invaluable to many types of research workers as well as to educators and practical men (HENRY A. WALLACE).

► MANUAL OF BRYOLOGY, *edited by* **Frans Verdoorn**, Ph. D. — A coöperative manual dealing with all aspects of the general botany of mosses and hepatics, as well as with the principles of bryological taxonomy and phylogeny. — *Published in coöperation with Messrs. Nijhoff, the Hague (1932)*; Roy. oct., cloth, 485 pp., 129 plates and illustr.......**$12.00**

Contents: van der Wijk: Morphologie und Anatomie der Musci; *Buch:* Morphologie und Anatomie der Hepaticae; *Buch:* Experimentelle Morphologie; *Chalaud:* Germination des spores et phase protonémique; *Nicolas:* Association des Bryophytes avec d'autres organismes; *Motte:* Cytologie; *Hoefer:* Karyologie; *Garjeanne:* Physiology; *von Wettstein:* Genetik; *Herzog:* Geographie; *Gams:* Quaternary distribution; *Gams:* Bryo-Cenology (Moss-Societies); *Richards:* Ecology; *Dixon:* Classification of Mosses; *Verdoorn:* Classification of Hepatics; *Zimmermann:* Phylogenie.

Practically a general text-book of Bryology. Bryology like other branches of botany, suffers from lack of co-ordination among its workers: those occupied in general research sometimes have very little knowledge of the plants with which they deal. The taxonomists on the other hand, do not pay enough attention to general botanical research on the group. The present manual is an attempt to meet some of these difficulties. The book which is clearly printed and admirably produced forms a valuable addition to general botanical literature ((JOURNAL OF BOTANY).

Obwohl ein Eingehen auf die einzelnen Darstellungen schon wegen ihres ausserordentlichen Reichtums an Einzelheiten hier nicht erfolgen kann, darf doch festgestellt werden, dasz sie durchweg hervorragende Spezialisten zu Verfassern haben. Es war die Absicht des Herausgebers, den Einzelforschern den ausreichenden und zuverlässigen Einblick in die Nachbargebiete zu erleichtern und das ist ihm, mit diesem in jeder Hinsicht ausgestatteten Handbuch, in verdienstvoller Weise gelungen (BOTANISCHES ZENTRALBLATT).

► MANUAL OF PTERIDOLOGY, *edited* by **Frans Verdoorn**, Ph. D. — A coöperative manual dealing with all aspects of the general botany of ferns and fern allies, as well as with the principles of pteridological taxonomy and phylogeny. — *Published in*

coöperation with Messrs. Nijhoff, the Hague (1938); Roy. oct., cloth, 640 pp., 121 plates and illustr...$14.00

Contents: *Schoute:* Morphology and anatomy; *Williams:* Experimental morphology; *Gregor:* Associations with fungi and other lower plants; *Burgeff:* Mycorhiza; *Docters van Leeuwen:* Zoocecidia; *Atkinson:* Cytology; *Döpp:* Karyologie; *Andersson-Kottö:* Genetics; *du Buy and Nuernbergk:* Growth, tropisms and other movements; *Wetzel:* Chemie und Stoffwechsel; *Gams:* Oekologie der extratropischen Pteridophyten; *Holttum:* The ecology of tropical pteridophytes; *Winkler:* Geographie; *Hirmer:* Geographie und zeitliche Verbreitung der fossilen Pteridophyten; *Kräusel:* Psilophytinae; *Walton and Alston:* Lycopodiinae; *Hirmer:* Psilotinae und Articulatae; *Christensen:* Filicinae; *Hirmer:* Fossile filicinae und pteridophyta incertae sedis; *Zimmermann:* Phylogenie.

The galaxy of twenty or more international authorities who have contributed under the able leadership of Fr. Verdoorn to the making of this unique volume on the pteridophytes makes this one of the outstanding botanical publications of the year. The articles are either in English or German, the illustrations are plentiful, and the printing leaves nothing to be desired (The Biologist).

This book, although intended mainly for botanists, will be appreciated by horticulturists who specialize in the cultivation of Ferns (The Gardeners' Chronicle).

► **FOREST SOILS AND FOREST GROWTH** *by* **S. A. Wilde**, Sc. D. (Univ. of Wisconsin). — The subject matter of a course given for upper class and graduate students in forestry, soils, botany, game management, and landscape architecture, embracing a wide field of biology and earth sciences pertinent to soils and forests. Deals at length with the origin and genetical properties of forest soils, their physics, chemistry, and biology, relation to forest vegetation, and importance in silvicultural management. — *A New Series of Pl. Sci. Bks., Vol. 18*; Sup. roy. oct., buckram, ca. 250 pp., illustrated, *in press, ready shortly* .... *ca.* $5.00

Contents: Historical and introductory. Genesis of forest soils. Genetic soil groups of the world: Upland soils; Hydromorphic and embryonic soils. Forest cover: its biological structure and its relation to environment. Physical properties of forest soils. Chemical properties of forest soils. Organisms of forest soils. Forest humus. Soil-forest types. Forest soil survey. Soils and tree planting. Amelioration of forest soils. Thinning and selective logging in relation to soils. Productivity of forest soil and forest management. Establishment of forest nurseries and control of nursery watering. Use of commercial fertilizers and lime in forest nurseries. Use of composts, liquid fertilizers, and green manure crops in forest nurseries. Adjustment of nursery soil fertility. Control of parasitic organisms in soils of forest nurseries.

A fair balance is maintained between the theoretical foundations and the practical aspects of forest land utilization. All phases of silviculture, *viz.*, nursery practice, tree planting, and selective logging are treated from an ecological standpoint. The bibliography of several hundred references is up-to-date and international in scope.

► **HAYFEVER PLANTS, THEIR APPEARANCE, DISTRIBUTION, TIME OF FLOWERING AND THEIR ROLE IN HAYFEVER** *by* **Roger P. Wodehouse.** Ph. D. (Lederle Laboratories). — This book brings together very nearly all of the botany that it is desirable to know in order to gain a clear understanding of the rôle that plants and their pollen play as causes of the allergies, hayfever and asthma. It could as well be called the *Botany of Hayfever* or the *Botany of Allergy*, though it is not intended to reach much beyond the botanical aspects of hayfever and asthma. — The book was written largely in response to questions that have come to the author from members of the medical profession, from plant scientists and from sufferers of hayfever. — *A New Series of Pl. Sci. Bks., Vol. 15 (1945)*; Sup. roy. oct., buckram, 245 pp., 73 illustr......$4.75

Contents: The botany of hayfever (The Flower. What makes some plants cause hayfever? Hayfever toxicity. Atmospheric pollen. Identification. Preparation of pollen slides. Botanical literature. Cultivated plants. The trees. Monographs of restricted groups). The hayfever plants: Gymnosperms. The hayfever plants: Angiosperms. Regional surveys (The northeastern states. The middle atlantic states. The Virginias and Carolinas. The northcentral states. The southern states. The southwest. Southern California. The north pacific states. The Rocky Mountain states. Plains and prairies). Glossary. Bibliography. Author Index. General Index.

The essentials of the various disciplines of botany are here brought together with the elimination of all materials not bearing directly on the study of hayfever and asthma. The book tells which plants cause hayfever, with special attention to the numerous and confusing vernacular and Latin names by which they have been designated in medical literature and elsewhere. It tells why certain plants cause hayfever while others, perhaps similar and closely related, do not. It tells how to recognize those which do by the structure of their flowers and inflorescences. It tells why hayfever plants grow in certain places and are excluded from others, and the effect of the impact of civilization on our environment in their distribution. It tells which are the primary and which the secondary causes of hayfever and their seasons of activity in the various floristic areas throughout North America. It tells how to catch grains of pollen out of the air and how to identify them and estimate their relative abundance.

Wodehouse's "Hayfever Plants" is indispensable to all physicians interested in allergy when managing their local hayfever problems, and it is the most complete authoritative text on the subject today. Medical allergists will welcome this authoritative book on the flora, responsible for clinical hayfever and asthma, indigenous to their respective areas, when treating their pollen-sensitive patients (Fred W. Wittich, M.D., *in* Annals of Allergy).

► **AN INTRODUCTION TO HISTORICAL PLANT GEOGRAPHY** *by* Dr. **E. V. Wulff** (Leningrad), *authorized translation by* **Elisabeth Brissenden.** *Foreword by* **Elmer D. Merrill.** — An original and authoritative account of the general and theoretical problems of historical plant geography, based on the author's famous Russian handbook, revised and brought up-to-date. This American edition has been prepared at the request of botanists from many parts of the world, as there exists not a similar modern book in English, German or French. — *A New Series of Pl. Sci. Bks., Vol. 10 (1943)*; Sup. roy. oct., 223 pp., 35 illustr. $4.75

The last few years have furnished to the phytogeographer such valuable new tools and so much fresh evidence, that a phase of expansion of the subject clearly lies ahead. Of this our botanical students are vaguely or not at all aware, and this first English text to reveal the new potentialities must therefore be valuable and welcome.—We can best convey the content of the book by the chapter headings: (1) historical plant geography: scope, relation to allied sciences, methods of investigation; (2) history of the science; (3) areas, their centres and boundaries; (4) the origin of areas; (5) types of areas; (6) parallelism in the geographical distribution of plants and animals and correlation between the distribution of parasites and that of their host plants; (7) artificial factors in the geographical distribution of plants; (8) natural factors in the geographical distribution of plants; (9) the migrations of species and floras and their causes; (10) historical causes for the present structure of areas and the composition of

---

[This] series of books on different branches of plant science is the most noteworthy contribution to synthesised botanical presentation that has appeared in recent years . . . The publication of these fine works, each admirable and authoritative in its own sphere, is all the more praiseworthy in view of the difficulties of the present time. Dr. Verdoorn is to be congratulated on the success which has attended his enthusiastic editorship.

Nearly all the volumes published so far, including some translations, have been in English. Dr. Verdoorn's remarks are of interest in this connection. "I feel", he writes, "that the volumes of an international series of books, such as the 'New Series of Plant Science Books', should as a rule be in English. An occasional volume in French, German or Spanish may be interspersed to emphasize the international character of the undertaking, but if it is to have a truly international distribution, a book should be in the dominant world language". For this our "one-language scientists" should be humbly grateful. (Compton *in* Journ. of So. African Botany).

floras; (11) concept of floral elements (GODWIN *in* NATURE).

In spite of the war, and that means much more in Russia than in America, it has been possible to arrange for Miss BRISSENDEN to work in close association with Dr. WULFF in Leningrad and then to publish the completed manuscript in this country. Once more science surmounts international boundaries and the catastrophes of war. As Dr. MERRILL states this volume "is a mine of logically and authoritatively discussed information on the subject." The book will be of special value to plant geographers, because it analyzes a large amount of continental, especially Russian, literature not otherwise readily available (MATHER *in* AMERICAN SCIENTIST).

▶ MARINE MICROBIOLOGY *by* **Claude E. ZoBell**, Ph.D. (Scripps Inst. of Oceanography). — A monograph on hydrobacteriology with special reference to the distribution, characteristics, and activities of bacteria and allied microorganisms in oceans, seas, and lakes. — *A New Series of Pl. Sci. Bks., Vol. 17 (1946)*; Sup. roy. oct., buckram, 240 pp., 12 illustr., numerous tables.............................$5.00

Contents: Introduction. The marine environment. Collection and examination of samples at sea. Methods of enumerating marine bacteria. Factors influencing the distribution of bacteria in the sea. Microorganisms in bottom deposits. Activities of microorganisms in bottom deposits. Characteristics of marine bacteria. Aquatic yeasts and molds. Transformation of organic matter. The nitrogen cycle in the sea. Bacteria which transform sulfur compounds. The phosphorus cycle. Relation of marine bacteria to flora and fauna. Microorganisms in marine air. Sanitary aspects of marine microbiology. Economic importance of marine microorganisms. Microbiology of inland waters. Comprehensive index of both subjects treated and species of marine bacteria, yeasts, and molds. Bibliography of 672 references complete with titles.

The book is written from an ecological point of view with emphasis upon the effect of bacteria upon the marine environment and the effect of environmental conditions upon the distribution of microorganisms. The importance of bacteria and allied forms as biochemical, geological, and hydrobiological agents is also stressed. The specialized methods of studying bacteria in oceans and lakes are adequately treated.

Available, without charge, upon request: —

'Plant Science Institutions and Societies of Latin America' (*from* "Plants and Plant Science in Latin America").

CANNON & FIELD, *International Relations in Science* (*from* CHRONICA BOTANICA 9, 5/6).

'A Portfolio of Plates mostly of historical interest and relating to Latin America' (*from* "Plants and Plant Science in Latin America").

'The Aims and Methods of Biological History and Biography' —chiefly prepared for contributors to the *Index Botanicorum* (CHRON. 8, 4).—*Cf.* the note on p. xii (*right*).

A Portrait of RAFINESQUE (*from* CHRONICA BOTANICA 8, 2).

Titles in preparation include: Botanical Terminology (ASMOUS), Vegetation of California (AXELROD & MASON), History of Genetics (BABCOCK), Cyto-Geography (BALDWIN), Cotton Diseases (BARKER), Veget. of the Himalayas (BISWAS), Angewandte Pflanzensoziologie (BOYKO), Recent Adv. in Soybean Research (BURLISON), Origins of American Agriculture (G. F. CARTER), The Genus Radula (H. CASTLE), Los Naturalistas en la America Latina (CHARDON), The Fig (CONDIT), Water Relations (CRAFTS), Seed Physiology (CROCKER & BARTON), The Vegetation of Canada (DANSEREAU), Paleobotany of Coal (DARRAH), The Vegetation of Florida (DAVIS), Potato Diseases (DIJKSTRA), Botánica Systemática (DUGAND), Vegetation of Palestine (EVENARI & ZOHARY), The Vegetation of the Rocky Mountains (EWAN), Travels in Tropical America (FOSBERG), Allgemeine Arealkunde (GAMS), Cereal Chemistry (GEDDES), The Genus Nicotiana (GOODSPEED), Comparative Plant Biochemistry (HAAGEN-SMIT), Bacterial Plant Diseases (HILDEBRAND), Vegetable Gums and Resins (F. N. HOWES), Vegetation of China (HU), History of Soil Science (G. V. JACKS), Phytopathology in the American Tropics (J. R. JOHNSTON), Ethnobotany of the Indians of N. America (V. H. JONES), Mycorrhiza in Plants (KELLEY), The Tomato (LUCKWILL), History of Botany in India (MAJUMDAR), The Slime Molds (MARTIN), Pollen and Honey (MAURIZIO), Bamboo (MCCLURE), Maize Diseases (MELHUS), Tree Mycorrhiza (MELIN), Coffee (A. J. T. MENDES), Selected General Writings (MERRILL), The Yeasts (NICKERSON), Biology of Pathogenic Fungi (NICKERSON, *ed.*), Soil Microbiology (NICOL), The Date Palm (NIXON), Problems and Methods in Bog and Swamp Research (OSVALD), Genera of Algae (PAPENFUSS), Vegetation of Argentina (PARODI), Jute (PATEL), Field Ecology (J. PHILLIPS), Phytologia Arctica (POLUNIN), Sugar Cane Diseases (RANDS), Vegetation of New England (RAUP), Tropical Plant Ecology (RAWITSCHER), Nuts and Nut Culture (C. A. REED), Ingenhousz as a Plant Physiologist (H. S. REED), Fusarium Diseases (REINKING), Vegetation der iberischen Halbinsel (ROTHMALER), Vegetation of the Hawaiian Islands (ST. JOHN), Ethnobotany of the Indians of Tropical America (SCHULTES), Hepaticae of N. E. America (SCHUSTER), Plant Life in the Caribbean (SEIFRIZ), Introduction to Bryogeography (SHARP), The Prairies and Plains of N. America (SHINNERS), Veget. of the American Desert (F. SHREVE), The Agaricales (Mushrooms) (SINGER), Manual of Phycology (G. M. SMITH, *ed.*), Manual of Aerobiology (STAKMAN, *ed.*), Physiologic Specialization in Phytopathogenic Fungi (STAKMAN & CHRISTENSEN), Genera of Mosses of N. America (STEERE), Histoire de la Botanique et de l'Agronomie aux Antilles Françaises (STEHLÉ), Nematode Diseases (STEINER), Plant Disease Control (N. E. STEVENS), Horticultural Plant Physiology (STOUGHTON), Growth Hormones in Horticultural Practice (STOUTEMYER), Fungous Diseases (TERVET), Wood Anatomy (TIPPO), Economic Phycology (TSENG), Hookeriana (TURRILL, *ed.*), Dictionary of Economic Botany (UPHOF), Tobacco Diseases (VALLEAU), Diseases of Bulbous Plants (VAN SLOCHTEREN), The Actinomycetales (WAKSMAN), The Genus Fontinalis (WELCH), Vernalization and Photoperiodism, A Symposium (WHYTE, MURNEEK & others), Herbage and Forage Crops (WHYTE & HALL), Plant Microfossils (L. R. WILSON), Thesaurus Lit. Hepaticologicae (F. & J. VERDOORN).

Most of the above titles will be published in "A NEW SERIES OF PLANT SCIENCE BOOKS" (*see p. ii*), *others in* ANNALES CRYPTOGAMICI ET PHYTOPATHOLOGICI (*see p. ii*), *and a few in* CHRONICA BOTANICA (*see p. xii*) *and simultaneously as separate books or booklets.*

Chronica Botanica

An international Collection of Studies in the Method and History of Biology and Agriculture

Founded and edited by FRANS *and* J. G. VERDOORN,

in coöperation with the following *advisory editors:* H. P. BARSS, P. CHOUARD, R. CIFERRI, L. DIELS, F. HESKE, G. E. HILBERT, D. H. LINDER, E. D. MERRILL, E. N. MUNNS, J. RAMSBOTTOM, Sir E. JOHN RUSSELL, E. W. SINNOTT, M. J. SIRKS, A. C. SMITH, K. SNELL, T. A. SPRAGUE, C. G. G. J. VAN STEENIS, N. E. SVEDELIUS, Acad. N. I. VAVILOV, F. W. WENT; *Assistant Editor and Bibliographer:* K. W. BARON (Waltham, Mass.); *Assistant Editors:* V. C. ASMOUS, P. J. CARABIA, L. CROIZAT, G. W. DILLON, H. ELIAS, TH. JUST, P. W. RICHARDS, R. E. SCHULTES, M. L. C. WALLE; *Corresponding Editors:* F. ANGELINI, A. ARBER, F. C. BAWDEN, A. A. BITANCOURT, A. BOROS, C. Y. CHANG, P. D. CRITOPOULOS, P. CUATRACASAS, W. C. DARRAH, TH. ECKARDT, J. FELDMANN, F. R. FOSBERG, H. GAMS, V. GIACOMINI, A. J. HAAGEN SMIT, A. HÄSSLER, K. L. HRUBY, J. VAN DER KLAAUW, J. LANJOUW, V. LATHOUWERS, H. N. MOLDENKE, Y. OGURA, H. R. OPPENHEIMER, H. OSVALD, W. POPENOE, M. M. RHOADES, A. J. RIKER, W. ROBYNS, W. ROTHMALER, H. SLEUMER, H. M. STEVEN, I. W. TERVET, K. V. THIMANN, W. B. TURRILL, S. A. WAKSMAN, JOH. WESTERDIJK, C. T. WHITE.

► Chronica Botanica aims primarily at the promotion of (1) international relations in the plant sciences, (2) studies in the history, method, and philosophy of biology and agriculture, (3) a better understanding between specialists in various branches of the plant sciences and their relations with the outside world.

The first three volumes of CHRONICA BOTANICA (1935/37) were published as annual records and reviews of current research, activities and events in the plant sciences. Vols. 4-7 (1938-1942) were published in periodical form, with the subtitle "the international plant science newsmagazine." From vol. 8 (1944) onwards CHRONICA BOTANICA contains more material than previously dealing with the basic humaniora of the plant sciences: history, methodology and philosophy. Much space, however, continues to be given to short discussions, news of all kinds, reviews, notices, etc. Every autumn we publish a special number (*Chronica Botanica Calendar*) entirely devoted to material of a timely interest, including such sections as *'Annual Report on International Relations Work in the pure and applied Biological Sciences,' The Forum, Quotations, The Chronicle, Serta Biographica, Reviews and Notices.*

CHRONICA BOTANICA is published bimonthly. An annual volume contains about 600 pages of memoirs, directories and census of current activities, articles and discussions, annotated reprints of important and rare classical papers, news, reviews and notices, etc., at $7.50 to regular subscribers (post free, foreign and domestic). — Orders may be sent directly to us, to any bookseller, or to our authorized agents as listed on p. i of this catalogue.

► A complete set of **Chronica Botanica** is a unique source of information on matters of practical, scientific, and historical interest, on the development and present status of plant science institutions and societies. It often enables one to trace the history of a project, a colleague, a laboratory or a garden in a few moments.—Back volumes (some of them covering two years) are still available at $7.50 (*paper*) or $8.75 (*buckram*), postage extra.

► Strong buckram binding cases, lettered in gold and exactly uniform with former volumes, may be had for any volume after vol. 3 (and your volumes should be bound for handy reference), at $0.75, post free, prepaid.—Orders for binders only should, if possible, be accompanied by a remittance.—We accept standing orders for binding cases and bill such orders when we issue the invoices covering the annual subscription to CHRONICA BOTANICA.

the Chronica Botanica Co., Waltham, Mass., U. S. A.

► The following issues of Chronica Botanica are available to non-subscribers:—

vol. 8, 1: BROWNE, A Source Book of Agricultural Chemistry .... p. 511
vol. 8, 2: C. S. RAFINESQUE, A Life of Travels .... p. 515
vol. 8, 3: BROWNE, Thomas Jefferson and the Scientific Trends of his Time ..... p. 511
vol. 9, 1: JACK, Biological Field Stations of the World .... p. 514
vol. 9, 5/6: HOWARD, W. L., Luther Burbank, A Factual Study .... p. 514
vol. 10, 1: DE SAINT-HILAIRE, Esquisse de Mes Voyages au Brésil et Paraguay . p. 516
vol. 10, 6: AGNES ARBER, Goethe's Botany p. 511
vol. 11, 3: COOPER, Arboretums, their Aims and Scope .... p. 512

About Chronica Botanica:—

. . . more valuable to the botanical world under present conditions than even in normal times (NATURE).

A remarkable achievement of editorial effort and co-operation . . . it covers a field not hitherto pre-empted, conflicts with no established periodical, supplements those already in existence, and should by its very name, encourage the spirit of international co-operation (JOURNAL OF BOTANY).

Die Botanik kann sich eines Organs rühmen, das bisher keine andere Wissenschaft kennt und das letzten Endes nichts mehr und nichts weniger bezweckt als eine Besinnung der Botaniker auf sich selbst als Glieder einer durch den Arbeitsgegenstand verbundenen internationalen Gemeinschaft (Z. FÜR BOTANIK).

► **The Index Botanicorum:** — In forthcoming volumes of the CHRONICA we will publish an extensive, critical, biographical dictionary of plant scientists of all times. A detailed note about this *Index Botanicorum,* which is being prepared with the assistance of the Arnold Arboretum of Harvard University, has been published in CHRONICA BOTANICA 8, 4 (1944). Reprints of this article (with detailed notes for contributors) are available upon request to those who may be interested to collaborate in the preparation of this biographical dictionary.

► *If you have any photographs or prints of agronomists, botanists, horticulturists, etc., pictures of plant science meetings, congresses, buildings, gardens, etc., biographical or historical reprints, and other documents, letters, autographs and plant science memorabilia of any kind, which are no longer of use to you, please send them to "Chronica Botanica Archives, the Chronica Botanica Co., Waltham 54, Mass." Material of this kind is carefully filed and made available to those of our numerous phytohistorical collaborators who can use it.*

► A special feature of CHRONICA BOTANICA are the international address lists and census of research which we publish from time to time. A list of taxonomists and ecologists was published in CHRON. BOT. 6, lists of research institutions and workers in Latin America were published in CHRON. BOT. 7. Our fourth "World List of Plant Science Institutions and Societies" was published in CHRON. BOT. 4 (1938). A revised edition of this will be published as soon as possible after the war.

► *The Editors of* CHRONICA BOTANICA *are grateful for all circulars, programmes, reports, notes, press communications, membership lists, directories, and other publications coming within the scope of their journal. To fulfill their purpose they rely on the active collaboration of institutions, societies and workers in all branches of the plant sciences.—Directors of herbaria, musea, and botanic gardens are earnestly invited to send us from time to time lists of their more important acquisitions.*